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Diverse Risks and the Relative Worth of Government Health and Safety Programs
An Experimental Survey

Charles River Associates, Inc., Boston, MA

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16. Abstract (Limit: 200 words)

This document reports the results of a preliminary examination of whether people place different values on reducing different kinds of risk. The focus of this exploratory effort is on mortality risks that could be altered by various government health and safety programs. Using a questionnaire with small experimental samples, the relative worths of 61 hypothetical lifesaving programs are estimated. An innovative approach is used, in which respondents balance hypothetical programs preventing different numbers of fatalities from different kinds of hazards. Each respondent's willingness to pay (WTP) for a particular type of program is assumed to be proportional to the number of fatalities prevented by the program. This allows calculation of the relative values for reducing different kinds of risk. Another part of the instrument asks directly for WTP additional taxes for health and safety programs, for comparison with the earlier results. Although the sample size is nonrandom and small, there is some indication that people do distinguish among the worths of different government health and safety programs, depending on the types of risks that are reduced.

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Final Report

DIVERSE RISKS AND THE RELATIVE WORTH OF GOVERNMENT HEALTH AND SAFETY PROGRAMS: AN EXPERIMENTAL SURVEY

Prepared for
Benefits Branch, Economic Analysis Division
Environmental Protection Agency
Washington, DC 20460

CRA Report No. 700.23

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June 1984

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PREFACE

The research presented in this report was supported under Prime Contract 68-01-6596, between the Economic Analysis Division of the Environmental Protection Agency and Charles River Associates. Ann Fisher served as EPA project officer. She guided and reviewed all phases of the project, in addition to making the all important initial contribution of asking the right question in the right way.

The questionnaire used in the study went through extensive internal review at CRA and EPA, including three major revisions. CRA reviewers included Ken Wise, Doug Rae, and Andrea Rae. Particular thanks go to Ann Fisher, Al McGartland and Brett Snyder of EPA, who reviewed early versions of the questionnaire that included much more material than we knew ultimately could be included in the final instrument.

Helpful reviews of the final report were received from Ann Fisher, Reed Johnson and John Harford. These reviews served mainly to reinforce the discussion at the end of the text describing required further investigations before results can provide a reliable basis for actual policy making. Among the points raised were the following: Concern was expressed about the implausibly low valuations placed on reducing risks from rare hazards by many respondents. Use of more sophisticated contingent-valuation techniques in Part III of the questionnaire was suggested. Further investigation of the true extent of diminishing marginal value from saving larger numbers of lives was encouraged. More detailed responses to the comments appear in Appendix E.

The major objective of this research project was to show the feasibility of a novel type of questionnaire for comparing the relative worths of saving lives from diverse types of risks, through government health and safety programs. The small experimental samples employed were sufficient for this purpose, but clearly are insufficiently representative to be regarded as more than a suggestion concerning the values of the whole nation.

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INTRODUCTION AND SUMMARY

For purposes of allocating limited resources among government health and safety programs, many people feel that the relative worth of preventing fatalities depends upon the nature of the hazard involved. For example, one common hypothesis is that greater worth is attached to saving lives from hazards which are "involuntary," such as air pollution, in comparison with more "voluntary" hazards such as highway accidents. This report describes experimental results from a questionnaire designed to investigate this issue. The relative worths of 61 hypothetical lifesaving government health and safety programs are estimated, and the importance of several underlying characteristics of the risks is tested. The remainder of this introduction summarizes the main topics and tentative conclusions from our experimental survey.

Small experimental samples, totaling 15 respondents, were recruited from the League of Women Voters of Newton, Massachusetts. The key type of question on the questionnaire requires respondents to balance hypothetical government programs preventing different numbers of fatalities from different kinds of hazards, in such a way that they are indifferent among the government programs. Our interpretation of respondents' answers (in Part II of the questionnaire) rests upon the assumption that each respondent's "Willingness to Pay" (WTP) for each kind of government health or safety program is proportional to the number of fatalities prevented by the program.

Regression analysis allows checking the consistency of each respondent's valuations of government programs that are considered more than once in Part II of the questionnaire, and averaging of the valuations where there is some inconsistency. The resulting "Basic Utility Function" for each respondent embodies estimates of the WTP for a government program reducing one kind of risk, divided by the WTP for a government program reducing another kind of risk. In the denominator of these ratios, we choose arbitrarily as a basis of comparison the prevention of highway fatalities among law-abiding automobile drivers; for reasons discussed later, we use the median results across all 15 respondents to characterize the central tendencies of the sample. On this basis, Part II of the questionnaire provides estimates of the median respondent's WTPs to prevent fatalities from 60 different kinds of hazards (divided by the WTP for law-abiding drivers), among which are the three important cases reported in the first column below:

	Trade-off Questions (Part II)	Direct WTP Questions (Part III)
Drivers speeding by 30 mph	0.48	0.10
Cancer from air pollution	1.06	2.50
Cancer from smoking cigarettes	0.39	0.20

Preventing fatalities from air pollution is considered slightly more important than preventing fatalities among law-abiding drivers, while preventing fatalities among smokers or drivers speeding by 30 mph is considered less important. In a similar fashion, Table 2 in the text gives results for a total of 60 diverse government health and safety programs. Further estimates, reported in Table 3, confirm that somewhat less worth is attached to preventing fatalities among elderly people, or among people whose health is impaired after they survive the risk.

For the three government programs considered above, the second column compares the relative WTPs obtained from Part III of the questionnaire, wherein respondents are asked directly about their Willingness to Pay additional taxes for government health and safety programs. As suggested by this small excerpt of results from Table 6 in the text, there is in general more variability among the relative WTPs estimated from the direct questions. These results from Part III are called the "Tax-Payments Utility Function."

Part I of the questionnaire allows limited investigation of risk characteristics which may determine the values expressed in Parts II and III of the questionnaire. There is very strong evidence that respondents favor government programs reducing risks to which they feel themselves most exposed. Extra worth is also almost always attached to preventing fatalities in the work place, especially among policemen and firemen. There is more spotty evidence that respondents favor government programs preventing fatalities from hazards that are considered "involuntary" or "unreasonably difficult to avoid." These results are embodied in what we call the "Risk-Characteristics Utility Function." (See Table 5.)

The results from the experimental samples described in this report strongly confirm that most respondents are willing to distinguish substantially among the worths of different government health and safety programs, depending on the kinds of risks that are reduced. Responses to the trade-off questions in Part II tend to be internally consistent, and other measures of statistical significance suggest as well that meaningful results have been obtained. (See Table 7.)

Appendix A considers the implications of asking respondents about the WTP for government programs, rather than the WTP for personal benefits alone. The conclusion is that societal averages for the two kinds of WTPs may not differ very much, despite sizable differences at the individual level. Even where there is a significant difference between the two societal averages, the average WTP for government programs can be a useful criterion for social choice.

THE EXPERIMENTAL QUESTIONNAIRE AND SAMPLES

Four small experimental samples, totaling 15 respondents, answered the questionnaire during March, April and May of 1984. The version of the questionnaire reproduced in Appendix D is slightly different from the version which the first respondents took. A few instructions were added to the questionnaire in order to clarify ambiguities which were identified during the first meetings and discussed verbally at that time. Despite these minor modifications to the questionnaire, we are confident that all respondents were similarly oriented so that it is valid to compare their responses, as we do in this report.

All versions of the questionnaire contain four parts. (See Appendix D.) Part I asks respondents (1) whether they think is is easy or hard to avoid exposure to different hazards, and (2) whether they are personally exposed to those hazards more or less than the average person in the United States. Part II asks respondents to compare the worth of 61 different government programs that reduce the risk of death from various hazards (such as automobile accidents and cancer from air pollution). Part III asks respondents how much new taxes they would be willing to pay for each of 12 specified new government health or safety programs. Finally, Part IV asks for background information about respondents. The median respondent took approximately an hour and 20 minutes to answer the questionnaire.

The questionnaire was administered to small groups of between three and six respondents at the home of the principal investigator, in Newton, Massachusetts. Respondents were invited at random from the 1983 membership list of the Newton League of Women Voters, using the form letter reproduced in Appendix C. A reply postcard was enclosed, which was particularly useful in cases where an invitee was unable to attend the next meeting but was interested in attending a later meeting.

Participants were offered a $25 fee in return for one to two hours of their time, an incentive which was intended to be generous. Unfortunately, even this fee was insufficient to induce a very high response rate, apparently because Newton is a prosperous suburb and members of the League of Women Voters tend to have crowded schedules. The total number of invitees required to obtain 15 participants was 105, so the response rate was only 14.3 percent. The overall response rate would have been even lower except for the fact that multiple meetings were held and repeat invitations were sent to people who had expressed an interest in participating but had been unable to attend an earlier meeting. About a third of the sample came only after their second or third invitation. However, approximately 18 invitees who expressed an interest in being invited to future meetings never were able to find a convenient date to come. Once committed, the respondents were very reliable. There was only one last minute cancellation, and there were no cases where a committed respondent failed to show up without notification.

This sample of course cannot be considered representative of all U.S. voters, which ultimately would appear to be the most relevant population for setting priorities among national health and safety programs. In fact, the sample may not even be very representative of the Newton League of Women Voters, given the somewhat low response rate. Participants tended to be people who had some prior interest in, and opinions about, government health and safety programs.

As one might expect, participants seemed to be well above average in intelligence and in tolerance for an unfamiliar and somewhat complicated type of questionnaire. Employing this type of experimental sample was a deliberate decision, since our immediate purpose was to test and refine a new type of survey instrument under favorable circumstances, rather than to obtain fully representative results.

The letter of invitation reproduced in Appendix C encouraged respondents "to identify any lack of clarity in the questionnaire and generally to suggest improvements." (The main reason the meetings were kept small was to facilitate this feedback.) Some participants warmed to this task, and a number of useful suggestions were made, particularly in terms of tightening up the language of the questionnaire to eliminate ambiguities which otherwise had to be clarified verbally. However, a number of red herrings were raised as well, and one of the meetings lasted almost two hours as a consequence. Later we briefly discuss some of the questions raised by respondents, particularly in terms of potential improvements to the questionnaire.

PART II: TRADE-OFFS AMONG DIFFERENT TYPES OF GOVERNMENT HEALTH AND SAFETY PROGRAMS

Part II is the heart of the questionnaire. It attempts to elicit the information which is most directly relevant for policymaking, and it employs the most innovative type of questions. In general terms, the questions take the following form: "How many lives would this government program have to save in order to be worth as much as that government program, given the types of risks which each program reduces?" We now describe more precisely how this information is elicited in Part II of the questionnaire. (The basic results obtained are presented below in Table 2, after discussion of our methods of interpretation and statistical summarization.)

A simplified example of the type of question employed on Part II (with a hypothetical respondent's answers already written into the boxes) is as follows:

	Average Number of Deaths Prevented	Hazard/Type of People at Risk of Death
(1)	11	Traffic accidents that kill drivers of automobiles who are obeying traffic laws (other people not involved).
(2)	25	Traffic accidents that kill drivers of automobiles who are going 30 mph over the speed limit while legally drunk (other people not involved).
(3)	10	Cancer from air pollution.

Three different government programs are (somewhat artificially) assumed to prevent deaths only of the types described. ("Innocent bystanders" are generally assumed away.) Respondents are asked to indicate quantitatively their preferences among the government programs by a procedure that we now explain.

Respondents are asked first (before they fill in the boxes) to compare all of the government programs and check off the one (or more) that is deemed most worthwhile, assuming that all programs (1) prevent the same number of deaths, and (2) cost the same. The respondent then puts "10" into the box for that government program (and possibly other "most worthwhile" programs). In the simplified example presented above, the respondent considered the government program preventing deaths due to cancer from air pollution to be the most worthwhile.

Given that the third government program above can be expected to prevent 10 deaths, the respondent is then asked to specify what larger number of deaths prevented would make the other government programs equally worthwhile in his or her judgment. In the simplified example presented above, the first government program would have to prevent 11 traffic fatalities among law-abiding drivers in order for the respondent to consider it just as worthwhile as preventing 10 fatalities under the third government program. Furthermore, the second government program would have to prevent 25 traffic fatalities among druken, speeding drivers in order for the respondent to be indifferent among the equally costly programs.

This procedure for comparing the relative values of different health and safety programs is the key mechanism used in the questionnaire, and the validity of the most extensive results reported below depends on the accuracy with which it measures the true preferences of respondents. The instructions in Part II of the questionnaire (see Appendix D) start with a simple example like the one given above, and explain comprehensively how to proceed. Most respondents had no difficulty understanding how to answer Part II, though they typically found the basic issues difficult because they had never before thought about them in such quantitatively precise terms.

INTERPRETATION OF PART II: THE BASIC ASSUMPTION

We assume the basic information reflected in Part II of the questionnaire concerns the respondent's "Willingness to Pay" (WTP) for each of the government programs considered. We explain below in detail how these WTPs are estimated from the questionnaire. Here we present only our basic assumption for interpreting the results of Part II.

That basic assumption, for each respondent, is that

WTP_i = Marginal value ("Willingness to Pay") for saving each statistical life through government program i

is constant for different sizes of government programs, over the range of sizes being considered. That is, for a given type of government program, the value to the respondent of saving 20 lives will be twice that of saving 10 lives, the value of saving 50 lives will be five times as great, and so on.

Results reported below are usually in terms of a "numeraire" government program, which we (arbitrarily) select to be one which prevents fatalities due to highway accidents among drivers who are obeying traffic laws (other people not involved). We represent the Willingness to Pay for the numeraire government program as "WTP_1". Consider now the numerical responses to the trade-off questions in Part II, which were illustrated above. If N_1 is the number of fatalities prevented by the numeraire government program (among law-abiding drivers) and N_i is the number of fatalities prevented by some other government program, chosen such that the respondent considers the two programs to be equally worthwhile, then the above basic assumption implies

$$(WTP_i)N_i = (WTP_1)N_1$$

or

$$WTP_i/WTP_1 = N_1/N_i$$

That is, the Willingness to Pay for one life saved through government program i, relative to the WTP for the numeraire program, equals the inverted ratio of the numerical responses to Part II. In qualitative terms, the higher the N_i required to make the i^{th} government program just as worthwhile as the numeraire, the lower the relative WTP (per life) for the i^{th} government program.

STATISTICAL ESTIMATION OF THE BASIC UTILITY FUNCTION FOR EACH RESPONDENT FROM PART II

As discussed above, the main results from the questionnaire are based on responses to the trade-off questions in Part II, using a quite straightforward basic assumption. However, the actual estimation of relative WTPs for each respondent is a bit more complicated than the simplicity of the above discussion may have suggested. The main reason is that there are 19 different sections in Part II, within each of which the government programs are to be independently balanced, and among which there is some repetition of government programs. The number of government programs per section ranges from three to ten. Where the same government program appears in several different sections, it serves to "link" responses to the sections and, beyond that, to provide some "cross-checking" of the relative valuations expressed. Since a government program with the highest value (per life saved) in one section may not be so valued in another section, the "scale" of the responses may differ among the sections. The statistical method described below accomodates these complications. We call the result of this estimation the Basic Utility Function for each respondent.

Statistical estimation of the Basic Utility Function for each respondent consists of a cross-section regression equation estimated over the numerical responses to Part II. These responses are denoted by

N_{ij} = Number of lives saved by the jth government program specified in section i of Part II, so that the government program is considered to be just as worthwhile as the other programs in section i.

Part II has 19 sections identified with capital letters, so that in the above notation $i = A, B, C, \ldots, S$. (See Appendix D.) Within each of these 19 sections, the number of government programs compared ranges from 3 to 10, so that in the above notation $j = 1, 2, \ldots, 10$ (maximum). The average number of government programs per section is between 5 and 6; the total number of responses from all 19 sections is 103.

The regression equations for the Basic Utility Functions are specified to be linear, incorporating the following variables:

Dependent Variable: $\log N_{ij}$

Explanatory Variables:

- 1 Constant term (always = 1).
- 60 Categorical variables ("dummy variables") for each of the government programs ($i = 2, 3, \ldots, 61$) other than the numeraire (Government Program 1).

- 18 Categorical variables for each section in Part II after section A (j = B, C, ..., S).
- 1 Categorical variable for those cases where life expectancy is halved after a fatality is prevented (rather than just being normal for the age group).
- 3 Categorical variables for age groups other than 40-49 (that is, 20-29, 60-69 and 80-89).

In total then, 83 coefficients are estimated. (Since only categorical variables are employed for the Basic Utility Function, estimation of this regression equation by Ordinary Least Squares is equivalent to doing Analysis of Variance.)

The basic reason that dependent variable N_{ij} is specified in logarithmic form is our basic assumption about respondents' preferences -- the constancy of the WTP per life saved for each type of government program -- which implies multiplicative consistency among the relative valuations of different government programs. For example, if Government Programs 1, 2, and 3 are independently compared to one another in a pairwise fashion in sections A, B, and C, one expects to observe the following relationship in the absence of respondent error:

$$(N_1/N_3)_C = (N_1/N_2)_A \ (N_2/N_3)_B$$

(The single subscripts on response N here indicate the unique government program number, as given in Part I of the questionnaire, not the possibly non-unique pair of identification numbers (i,j) from Part II.) The above multiplicative relationship translates into an additive relationship among the logarithms, corresponding to the log-linier specification described above.

The questionnaire is sufficiently complicated so that it would be very surprising if a respondent managed to be completely consistent when comparing repeated government programs in all 19 sections of Part II, even if our basic assumption about the constancy of WTP_i for different numbers of lives (of a particular type) saved was true. Estimating the regression equation specified above in effect "averages out" all the relative valuations for government programs that are repeated. Roughly speaking, this specification also implies that the dispersion of response error is proportional to the size of the respondent's "true" N_{ij} (which, in principle, is not necessarily observed). That is, we assume an error of ±10 where the true $N_{ij} = 100$ is as likely as an error of ±1 where the true $N_{ij} = 10$. We judge this error assumption is most likely to avoid impairment of the estimation due to heteroscedasticity, and we count this implication of the logarithmic dependent variable as another advantage of that specification.

The statistical estimation of each Basic Utility Function thus serves as a check on the consistency of responses for each member of the sample, and as an "averaging out" procedure where a government program is considered more than once. With 103 observations on N_{ij} and 83 parameters estimated, only 20 "degrees of freedom" are left for this cross-checking. Within each section, at least one government program must be repeated from other sections to "link" the results of that section (as indicated by the 18 degrees of freedom used to estimate the coefficients of the section dummies in the regression specification presented above). Roughly speaking then, the 20 remaining degrees of freedom correspond to repetitions of government programs among the 19 sections of Part II beyond the 18 repetitions required for linkage without any cross-checking.

The coefficients of the explanatory variables in the Basic Utility Function listed above are all presented in this report in a "multiplicative" form (rather than the additive form in which the equation was originally estimated), by raising the logarithmic base to the power of the coefficient. To be more specific, for one of the 60 dummy variables representing a government program,

$$\exp(-\text{coefficient } i) = \text{estimate of } WTP_i/WTP_1.$$

That is, exp(-coefficient) is the estimated Willingness to Pay for the i^{th} government program relative to the Willingness to Pay for the numeraire program (which prevents traffic fatalities among law-abiding drivers). The results from Part II of the questionnaire only provide estimates of these ratios, not absolute dollar estimates of each WTP. (An exploratory effort to elicit absolute WTPs is made in Part III of the questionnaire. However, as discussed later, we have serious reservations about the meaningfulness of those results.)

In the regression equation for the Basic Utility Function, the coefficients for the constant term, and for the 18 sections after section A, are artifacts of the questionnaire's structure which are not of substantial interest. The other substantive results from the Basic Utility Function indicate the relative value of government programs where, other things equal, beneficiaries of the program are in different age groups or are afterward less healthy than average for their age groups. For the age-group dummy variables, exp(-coefficient) measures the WTP for age groups 20-29, 60-69, or 80-89, relative to "reference" age group 40-49. For the dummy variable indicating that lives are saved but survivors' life expectancies are only half of normal for their age group, exp(-coefficient) measures the WTP relative to the "reference" case where the life expectancy of survivors is normal for their age group.

There is a substantive assumption built into the regression equation for the Basic Utility Function that the relative effects due to differences in age-groups or impaired health afterward are the same for all government programs. To the extent that this simplifying assumption does not hold, the resulting specification error tends to produce a lesser "goodness of fit" for the Basic Utility Function which is indistinguishable from that which occurs when the respondent specifies somewhat inconsistent relative values for the same government program in different sections of Part II. Thus, the statistical significance of the regression relationship reflects the validity of this assumption as well as the consistency of the relative valuations. However, in fact the major reason for a "poor fit" is usually inconsistency in expressing relative valuations.

DESCRIPTIONS OF GOVERNMENT PROGRAMS PREVENTING FATALITIES FROM VARIOUS TYPES OF RISKS

As indicated above, government programs reducing 61 different types of risks are distinguished on the questionnaire. These 61 risk types are described in Table 1, first in a "short" form that will be used throughout much of the following discussion, and then in the "full" form actually used on the questionnaire. (See in particular Part I of the questionnaire in Appendix D; the descriptions of the risks in Part II are quite similar, and are intended to represent the same situations to respondents.) Needless to say, the full descriptions should be carefully consulted before any policy implications are drawn from the results of this survey.

Even the "full" descriptions of the risks presented in Table 1 are very sketchy, relative to all the information one might desire before making a judgment about the relative worths of reducing different types of risks. As indicated above, the questionnaire also specifies (1) the age group for whom risks are reduced, and (2) cases in which the health of survivors is afterward reduced (to the extent that lifetimes are halved). However, many other unspecified details could significantly affect respondents' answers as well.

The general assumption respondents are asked to make regarding all unspecified details is that "deaths are reduced by the same proportion everywhere in the United States, for all kinds of people, regardless of whether they know about the hazard or not." (See the top of page D-16 of the questionnaire, in Appendix D.) That is, each respondent must rely on his or her understanding of the (U.S.) distribution of relevant-but-unspecified circumstances surrounding fatalities in each of the risk categories, for each of the government programs.

For example, when weighing the worth of reducing fatalities due to "fires from faulty gas room heaters in single-family houses" (Government Program 25), most respondents, consciously or unconsciously, probably make some assumption about

Table 1

DESCRIPTIONS OF GOVERNMENT PROGRAMS PREVENTING FATALITIES FROM 61 DIFFERENT TYPES OF RISKS: SHORT DESCRIPTIONS AND FULL DESCRIPTIONS

Number for Government Program (Risk Type) and SHORT DESCRIPTION	FULL DESCRIPTION used on questionnaire
1. Law-abiding drivers	Highway accidents that kill drivers of automobiles who are obeying traffic laws -- other people not involved.
2. Speeding by 15 mph	Highway accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 15 mph (but are not legally drunk) -- other people not involved.
3. Speeding by 30 mph	Highway accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 30 mph (but are not legally drunk) -- other people not involved.
4. Speeding by 15 mph, drunk	Highway accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 15 mph and whose alcohol blood levels make them legally drunk -- other people not involved.
5. Passengers of law-abiding drivers	Highway accidents that kill passengers in automobiles whose drivers are obeying traffic laws.
6. Passengers of speeders by 30 mph	Highway accidents that kill passengers in automobiles whose drivers are exceeding the 55 mph speed limit by 30 mph (but are not legally drunk) -- other cars not involved.
7. Passengers on regular airlines	Airplane accidents that kill passengers of regularly scheduled airlines.
8. Crews on regular airlines	Airplane accidents that kill pilots and crews of regularly scheduled airlines.
9. People near airport	Airplane accidents that kill people on the ground who have chosen to buy a less expensive house near an airport.

Table continued on next page.

Table 1 Continued

10.	People not near airport	Airplane accidents that kill people on the ground who are not near an airport or other area with high airplane traffic.
11.	Cancer from air pollution	Cancer from air pollution.
12.	Cancer from manmade radiation	Cancer from manmade radiation in the general environment.
13.	Cancer from smoking cigarettes	Cancer from smoking cigarettes.
14.	Cancer from illegal dumping	Cancer from unauthorized dumping of toxic waste in residential areas.
15.	Cancer from pesticides in foods	Cancer from residual insecticides and herbicides in foods.
16.	Cancer from artificial sweeteners	Cancer from artificial sweeteners.
17.	Cancer from IUDs	Cancer from intrauterine devices (IUDs).
18.	Cancer from river pollution	Cancer from chemical pollution of streams, lakes and rivers.
19.	Heart attacks	Heart attacks.
20.	Strokes	Strokes.
21.	Botulism in canned goods	Boltulism poisoning in canned foods purchased at a grocery store.
22.	Home electrical wiring fires	Fires from faulty electrical wiring in single-family houses.
23.	Home hair dryer fires	Fires in single-family houses from leaving hair dryers running near flammable material.
24.	Hair dryers in bathtub	Electrocutions from using hair dryers while bathing.
25.	Home gas heater fires	Fires from faulty gas room heaters in single-family houses.

Table continued on next page.

Table 1 Continued

26.	Home Christmas tree fires	Fires from faulty Christmas tree lights in single-family houses.
27.	Home lightning fires	Fires from lightning striking single-family houses.
28.	Smoking-in-bed fires	Fires in single-family houses from inhabitants falling asleep while smoking.
29.	Apartment electrical wiring fires	Fires from faulty electrical wiring in apartment buildings.
30.	Office electrical wiring fires	Fires from faulty electrical wiring in office buildings.
31.	Night club wiring fires	Fires from faulty electrical wiring in night clubs.
32.	Tornados	Tornados.
33.	Flash floods, travelers	Flashfloods striking travelers with no warning.
34.	Flash floods, homes	Flash floods striking people who chose to buy a less expensive house in a known flood plan.
35.	Lightning striking people	Lightning striking people.
36.	Beachfront storms	Extraordinarily high storm tides, striking people who have chosen to live at the beachfront.
37.	Policemen	Policemen killed in the general line of duty.
38.	Coal miners	Coal mining accidents.
39.	Farmers on tractors	Accidents killing famers on tractors.
40.	Firemen	Accidents killing firemen in the general line of duty.
41.	Truck drivers	Highway accidents killing long-haul truck drivers who are obeying traffic laws.

Table continued on next page.

Table 1 Continued

42.	Highway construction workers	Accidents killing highway construction workers.
43.	Steeplejacks, etc.	Accidents during construction and repair work high above the ground (by ironworkers, steeplejacks, etc.)
44.	Movie stunt men	Accidents to movie stunt men.
45.	Job cancer, no information	Cancer from having worked in a job where there was no information of increased cancer risk.
46.	Job cancer, with information	Cancer from having worked in a job where there was extensive information of increased cancer risk.
47.	Alcoholics	Cirrhosis of liver from extreme alcohol consumption.
48.	Drug addicts	Drug overdoses by drug addicts.
49.	Drownings, supervised pool	Drownings while swimming in a supervised pool.
50.	Drownings, unauthorized quarry	Drownings while swimming alone in an abandoned quarry clearly marked as "dangerous" and "private property -- keep out".
51.	Drownings while boating	Drownings while boating.
52.	Drownings while scuba diving	Drownings while scuba diving.
53.	Surgery, fatal diseases	Fatal complications during surgical operations to slow the progression of diseases that are expected to cause death eventually.
54.	Surgery, severe pain	Fatal complications during surgical operations to alleviate severe pain.
55.	Surgery, cosmetic	Fatal complications during major cosmetic surgery.
56.	Passengers on intercity buses	Passengers on intercity buses killed in highway accidents.

Table continued on next page.

Table 1 Continued

57.	Passengers on private planes	Passengers on small private planes, with non-professional pilots, killed in accidents.
58.	Passengers on railroads	Passengers on railroads, killed in accidents.
59.	Motorcyclists	Motorcyclists killed in accidents.
60.	Bicyclists	Bicyclists struck by automobiles and killed.
61.	Pedestrians struck by autos	Pedestrians struck by automobiles and killed.

SOURCE: Charles River Associates, 1984.

the proportion of U.S. victims who know before such fires that their heaters are faulty. Other things equal, respondents who think the proportion of people with prior knowledge is high probably tend to have a lower WTP to reduce fatalities of that type. If good information can be obtained on the proportion of people with prior knowledge, one strategy for constructing a more incisive survey instrument would be to inform respondents about that proportion.

The preferable procedure, which we employ to some extent in this study, is to disaggregate the risk category. Although "home gas heater fires" are not disaggregated according to the extent of prior knowledge, fatalities from highway accidents are broken down into eight distinct risk categories:

1. Law-abiding drivers
2. Speeding by 15 mph
3. Speeding by 30 mph
4. Speeeding by 15 mph, drunk
5. Passengers of law-abiding drivers
6. Passengers of speeders by 30 mph
41. Truck drivers [law-abiding]
56. Passengers on intercity buses

(See the full descriptions of these government programs in Table 1.) Responsibility then falls on the analyst to allocate the benefits of prospective government programs among these risk categories, weighting the relative WTPs from the survey accordingly.

RESULTS FOR THE BASIC UTILITY FUNCTIONS FROM PART II

Table 2 reports the results for the 61 different risk categories considered in the Basic Utility Function, as estimated for each of the 15 respondents from Part II of the questionnaire. Attention focuses on the distribution across all 15 respondents of the WTP for reducing fatalities due to each specified risk, relative to the WTP for law-abiding drivers. The central tendency of this distribution of "WTPs relative to the numeraire" is characterized in Table 2 by the median response across all 15 respondents. That is, the "relative WTPs" (WTP_i/WTP_1, as described above) are first estimated for each respondent and then rank-ordered from lowest to highest. The "middle" relative WTP (that is, the eighth highest or lowest among all respondents) is reported in Table 2 as the MEDIAN.

The dispersion and skewness of relative WTPs around their medians are characterized by the other quartiles of their distributions. Since there are 15 respondents, the Lower Quartile equals 0.75(4th lowest) + 0.25(5th lowest) and the Upper Quartile equals 0.25(11th lowest) + 0.75(12th lowest). For a sample of size 15, the resulting interquartile range can be interpreted as a 90 percent confidence interval with respect to the true population median. Many of these intervals are quite wide, indicating the need ultimately to sample more people.

Table 2

BASIC UTILITY FUNCTIONS: WTP FOR REDUCING FATALITIES DUE TO SPECIFIED RISKS, RELATIVE TO THE WTP FOR LAW-ABIDING DRIVERS (THE NUMERAIRE), RANKED BY MEDIAN RESPONSE AND INCLUDING LOWER AND UPPER QUARTILES.

Number for Government Program (Risk Type) and Short Description		Quartiles Across 15 Respondents		
		Lower	MEDIAN	Upper
36	Beachfront storms	0.101	0.203	0.420
48	Drug addicts	0.100	0.231	0.419
4	Speeding by 15 mph, drunk	0.051	0.239	0.869
47	Alcoholics	0.211	0.292	0.461
34	Flash floods, homes	0.129	0.302	0.525
24	Hair dryer in bathtub	0.157	0.310	0.667
50	Drownings, unauthorized quarry	0.200	0.330	0.500
27	Home lightning fires	0.187	0.388	0.643
13	Cancer from smoking cigarettes	0.188	0.388	0.763
44	Movie stunt men	0.166	0.400	0.667
23	Home hair dryer fires	0.261	0.401	0.667
35	Lightning striking people	0.181	0.403	1.000
3	Speeding by 30 mph	0.135	0.477	0.997
33	Flash floods, travelers	0.164	0.478	0.647
52	Drownings while scuba diving	0.110	0.498	0.995
55	Surgery, cosmetic	0.100	0.500	0.667
28	Smoking-in-bed fires	0.128	0.502	0.667
57	Passengers on private planes	0.186	0.503	0.667
59	Motorcyclists	0.245	0.503	0.880
26	Home Christmas tree fires	0.342	0.557	1.000
32	Tornadoes	0.189	0.628	0.806
17	Cancer from IUDs	0.458	0.642	0.935
16	Cancer from artificial sweeteners	0.188	0.706	0.935
31	Night club wiring fires	0.124	0.712	1.000
25	Home gas heater fires	0.427	0.754	1.000
22	Home electrical wiring fires	0.620	0.783	1.052
6	Passengers of speeders by 30 mph	0.352	0.851	1.000
9	People near airport	0.432	0.863	1.000
20	Strokes	0.616	0.872	1.000
46	Job cancer, with information	0.446	0.872	1.000
43	Steeplejacks, etc.	0.533	0.883	1.000
10	People not near airport	0.344	0.883	1.010
41	Truck drivers	0.579	0.885	1.000
60	Bicyclists	0.757	0.886	1.000
38	Coal miners	0.776	0.908	1.000

Table continued on next page.

Table 2 Continued

Number for Government Program (Risk Type) and Short Description		Quartiles Across 15 Respondents		
		Lower	MEDIAN	Upper
39	Farmers on tractors	0.577	0.908	1.000
40	Firemen	0.590	0.908	1.000
42	Highway construction workers	0.776	0.908	1.000
37	Policemen	0.561	0.913	1.000
5	Passengers of law-abiding drivers	0.869	0.943	1.000
19	Heart attacks	0.645	0.969	1.037
49	Drownings, supervised pool	0.328	0.979	1.000
2	Speeding by 15 mph	0.651	0.982	0.999
56	Passengers on intercity buses	0.880	0.982	1.120
58	Passengers on railroads	0.880	0.982	1.005
61	Pedestrians struck by autos	0.880	0.982	1.005
21	Botulism in canned goods	0.436	0.988	1.005
51	Drownings while boating	0.617	0.989	1.189
8	Crews on regular airlines	0.837	1.000	1.000
15	Cancer from pesticides in foods	0.969	1.000	1.005
18	Cancer from river pollution	0.969	1.000	1.112
30	Office electrical fires	0.817	1.000	1.112
54	Surgery, severe pain	0.667	1.000	1.049
12	Cancer from manmade radiation	0.986	1.000	1.000
14	Cancer form illegal dumping	0.986	1.000	1.181
7	Passengers on regular airlines	0.961	1.010	1.181
11	Cancer from air pollution	0.988	1.059	1.186
45	Job cancer, no information	0.988	1.059	1.257
29	Apartment electrical wiring fires	0.928	1.068	1.414
53	Surgery, fatal diseases	0.730	1.157	1.566

SOURCE: Charles River Associates, 1984.

In the absence of response errors, the mean (average) WTP is more directly relevant as a social criterion than is the median (where there is a difference between these two measures of central tendency). However, given the conceptual difficulty of the questionnaire and the substantial likelihood of outliers, the median was judged to be a more robust and hence superior summary statistic for present purposes. (The complete distribution of relative WTPs for all 15 respondents and all types of risks (government programs) are displayed in Appendix B.)

The general pattern of results from the Basic Utility Functions summarized in Table 2 is quite plausible, though there are a number of possible surprises and several anomalies that probably are attributable to imperfections in the questionnaire as an instrument for measuring respondents' true preferences. We now discuss these results, focusing on subsets of similar risk types within which it is easier to judge the plausibility of the results.

It is perhaps surprising that the lowest median relative WTP (0.203) is to prevent fatalities from "extraordinarily high storm tides, striking people who have chosen to live at the beachfront." The relative WTP to prevent fatalities from "flash floods striking people who chose to buy a less expensive house in a known flood plain" is nearly as low (median = 0.302). Possible reasons for such valuations will be discussed in some detail below, particularly when we present results for the Risk-Characteristics Utility Function. However, roughly speaking respondents apparently felt that people exposed to those risks are largely responsible for their own predicament and are less deserving of government protection. In comparison, buying a home near an airport apparently was considrerd a less foolhardy decision, since the relative WTP for Government Program 9 is 0.863. This result is only slightly lower than the median for buying a home not near an airport, at 0.883.

As might be expected, the relative WTPs to prevent fatalities among drug addicts and alcoholics are low (medians = 0.231 and 0.292 respectively). (Respondents were told verbally that the government programs in question treated people who had already become addicted to drugs or alcohol; they were not "preventative" programs designed to convince people not to use drugs or alcohol. This specification will be made explicit on future versions of the questionnaire.)

The median relative WTP to prevent fatalities among drunken drivers speeding by 15 mph is also low (0.239). The dispersion of responses for this type of risk is unusually large. The lower-quartile relative WTP of 0.051 is the lowest among all the government programs. However, the upper-quartile relative WTP is fairly high at 0.869.

It seems likely that several respondents failed to appreciate fully the questionnaire's instructions to assume "other people not involved" in the accidents killing drunken drivers. The general instructions for Part II attempted to orient respondents to accept this type of artificial assumption -- that government programs could be designed to help only the drunken drivers and not their innocent victims. Moreover, the respondents were told verbally that they were to "assume away the possibility of innocent bystanders" throughout Part II of the questionnaire. However, it is so ingrained to sympathize with the innocent victims of drunken drivers that this perspective probably contributed to the fairly high upper quartile.

Another possible explanation is that some respondents may have felt that the criterion for being legally drunk is overly strict and driving 15 mph over the speed limit is not very extreme. The median relative WTP for drivers speeding by 15 mph (over the 55 mph limit) but not drunk is 0.982, which is nearly as high as for preventing fatalities among law-abiding drivers. (The relative WTP for the numeraire equals one, by definition, for all respondents.) For drivers speeding by 30 mph but not legally drunk, the median relative WTP is 0.477.

Table 2 indicates lack of sympathy with those who are electrocuted while using hair dryers in the bathtub (median = 0.310), or who drown while swimming alone in an abandoned quarry (median = 0.330). There is not much more sympathy for those leaving hair dryers running near flammable material (median = 0.401).

Preventing cancer fatalities due to smoking cigarettes (median = 0.388) is considered somewhat more worthwhile than preventing fatalities among drug addicts and alcoholics, but not by a wide margin. For fires caused by smoking in bed, the median relative WPT is somewhat higher, at 0.502.

The low median relative WTP to prevent fatalities due to "fires from lightning striking single-family homes" (0.388) is surprising, since such accidents would seem to be an "act of God." It may be that respondents thought that this type of fatality is easy to prevent (though lightning rods are not common in Newton). However, a more plausible explanation points toward a likely inadequacy of the questionnaire. In particular, conversations with respondents after they had filled out the questionnaire suggested that some had attached less importance to reducing certain risks that they regarded as notably "rare." That is, their answers for those government programs in Part II indicated that a large number of fatalities would have to be prevented in order for them to be indifferent among government programs.

Some analysts have hypothesized that many people truly feel it is less worthwhile to prevent one U.S. fatality among a total of 5 (of a given type) than it is to prevent one U.S. fatality among 50,000. This state of affairs is possible, but it seems much more likely that such responses reflect a thought pattern for dealing with policy issues that would be superseded upon more extended and careful consideration than was possible while answering our questionnaire. It is perhaps common to confuse paying less in total to save a small number of lives from a rare hazard (which is rational by usual standards) and paying less per person (which seems questionable.) If this assessment is accurate, improvements in the questionnaire may make it more likely that responses will reflect more deep-seated preferences rather than common mental shortcuts. For instance, Part II of the questionnaire might encourage respondents actually to visualize groups of (10 or more) beneficiaries that are compared when specifying the trade-offs among the government programs.

Another possible reason that respondents may attach inadequate weight to prevention of fatalities from rare hazards is a notion that might be characterized as "external benefits." That is, if a government program helps one person out of 50,000 nationwide, rather than one person out of 5, then there may seem to be a greater likelihood that a way will be found to help still more people . This perspective is completely inconsistent with the hypothetical "ceteris paribus" assumptions that respondents to the questionnaire are asked to accept. Part II of the questionnaire might be improved by further emphasizing the need for this perspective (in order to minimize ambiguity in interpreting the results).

Other types of rare hazards appear to be affected by the same type of response phenomenon as "home lightning fires" (median = 0.388, as noted above). For "lightning striking people," the median relative WTP is 0.403 -- though the upper quartile is 1.000, indicating that a significant number of respondents interpreted this to be an "act of God," as seems most plausible to us. For "flash floods striking travelers with no warning," the median is 0.478. This situation also was intended to be interpreted as an "act of God." These low median responses suggest that the very low medians for "flash floods, homes" and "beachfront storms" (Government Programs 34 and 36 respectively) may be due in part to the "rare hazard" phenomenon under discussion. The fairly low medians for "home Christmas tree fires" (0.557) and "tornadoes" (0.628) may also be due to the rarity of fatalities from those hazards (though fatalities from tornadoes typically receive widespread publicity, so that result is perhaps somewhat more surprising).

The questionable responses for rare hazards discussed above are a significant concern. However, it is certainly true also that rare hazards, almost by definition, represent a less important policy problem.

Median relative WTPs for various occupational hazards follow a plausible pattern:

● Movie stuntmen	0.400
● Job cancer, with information	0.872
● Steeplejacks etc.	0.883

• Truck drivers	0.885
• Coal miners	0.908
• Farmers on tractors	0.908
• Firemen	0.908
• Highway construction workers	0.908
• Policemen	0.913
• Crews on regular airlines	1.000
• Job cancer, no information	1.059

Median relative WTPs for various "recreational" hazards also follow a plausible pattern:

• Drownings, unauthorized quarry	0.330
• Drownings while scuba diving	0.498
• Motorcyclists	0.503
• Bicyclists (adult)	0.886
• Drownings, supervised pool	0.979
• Drownings while boating	0.989

The comparatively high median for boating accidents is perhaps a bit surprising, though results presented in Table 4 below suggest that boating was a bit more popular recreational activity among respondents than either bicycling or swimming in a supervised pool.

Median relative WTPs for various types of surgery follow a plausible pattern:

• Surgery, cosmetic	0.500
• Surgery, severe pain	1.000
• Surgery, fatal disease	1.157

Two respondents made the useful suggestion that a distinction be drawn between cosmetic surgery to restore normal appearance after an accident or a birth defect, and cosmetic surgery (such as a facelift) which is motivated only by a desire to look younger. The case of "operations to slow the progression of diseases that are expected to cause death eventually," listed third above, apparently struck a particularly sympathetic chord among respondents. It has the highest median relative WTP among all 61 types of risks considered on the questionnaire. (However, it should be noted that this government program was presented in Section R of Part II only in the context of "death prevented, but life expectancy of survivors is only half of average for the indicated age group." Thus, the above result depends on the uniform multiplicative effect of a halved life expectancy which was assumed for all government programs in the specification of the Basic Utility Function, as discussed earlier.)

Median relative WTPs for various types of passengers follow a plausible pattern (pedestrians are also compared):

Passengers on private planes	0.503
Passengers of speeders by 30 mph	0.851
Passengers of law-abiding drivers	0.943
Passengers on intercity buses	0.982
Passengers on railroads	0.982
Pedestrians struck by autos	0.982
Passengers on regular airlines	1.010

Median relative WTPs for various types of fires follow a plausible pattern:

Night club wiring fires	0.712
Home gas heater fires	0.754
Home electrical wiring fires	0.783
Office electrical fires	1.000
Apartment electrical fires	1.068

Respondents apparently felt that victims of fires due to faulty wiring in office buildings and apartment buildings are less able to protect themelves from that type of hazard than are home owners. Some sort of moralistic judgment probably explains the low median for "night club wiring fires."

Median relative WTPs for several diverse health problems not yet discussed are not greatly different:

Strokes	0.872
Heart attacks	0.969
Botulism in canned goods	0.988

Of particular interest to EPA are the results for cancer caused by environmental hazards, all of which had median relative WTPs among the highest of those considered (cancer fatalities from decisions about personal care products and jobs are included for comparison):

Cancer from IUDs	0.642
Cancer from artificial sweeteners	0.706
Job cancer, with information	0.872
Cancer from pesticides in foods	1.000
Cancer from river pollution	1.000
Cancer from manmade radiation	1.000
Cancer from illegal dumping	1.000
Cancer from air pollution	1.059
Job cancer, no information	1.059

It is apparent from the results reported above, and from the rest of Table 2, that saving the lives of law-abiding drivers was given a high priority by most respondents. Only five types of risks have median WTPs greater than the WTP for this numeraire (relative WTP = 1.000 for law-abiding drivers by definition for all respondents). To some extent, this result probably reflects the fact that all but one of the respondents are themselves automobile drivers who drove to the survey meeting in their home town of Newton, Massachusetts. (See also Table 4.)

RESULTS FOR DIFFERENT AGE GROUPS AND IMPAIRED HEALTH EFFECTS

Table 3 reports the results from the Basic Utility Functions for different age groups and impaired health effects, in the same fashion that different types of risks were considered above. The numeraire situation, relative to which these effects are measured, is one in which the survivors benefiting from a government program are in their 40s and have unimpaired health after their survival. Most of the respondents to the questionnaire were in their 40s or 50s, so it is perhaps not very surprising that the majority attached no premium to preventing fatalities among people in their 20s. In fact, the median WTP for the 20-29 age group is only 97.7 percent of that for the 40-49 age group (other things equal), as reported in the top row of Table 3. However, the upper quartile of 1.459 indicates that at least four or five respondents did attach substantial premiums to preventing fatalities among people in their 20s.

Results in Table 3 for older beneficiaries of the government programs follow a plausible pattern. The median relative WTP for preventing fatalities among people in their 60s is 72.9 percent. For people in their 80s the ratio is 45.4 percent.

For government programs which prevent death but leave survivors with a life expectancy that is only half of normal for the specified age group, the median relative WTP is 70.3 percent (compared with the usual case on the questionnaire where people are assumed to have unimpaired health after survival).

RESPONDENT CHARACTERISTICS AND THE WTP TO PREVENT CANCER FATALITIES DUE TO AIR POLLUTION

When future versions of the questionnaire have been applied to larger numbers of respondents with more diverse backgrounds, it will be useful to analyze relationships between the characteristics of respondents and the values they express. Beyond the considerable intrinsic interest of this analysis, it will allow better extrapolation of results from non-random samples to estimates for the entire population of U.S. voters.

Table 3

BASIC UTILITY FUNCTIONS*: WTP FOR DIFFERENT AGE GROUPS AND FOR IMPAIRED HEALTH EFFECTS, MEASURED RELATIVE TO THE WTP FOR PEOPLE AGED 40-49 WHOSE HEALTH IS NOT IMPAIRED.

	Quartiles Across 15 Respondents		
	Lower	MEDIAN	Upper
Age Groups:			
20-29	0.933 (0.952)	0.977 (1.019)	1.459 (1.430)
60-69	0.392 (0.389)	0.729 (0.721)	0.885 (0.903)
80-89	0.200 (0.205)	0.454 (0.442)	0.740 (0.729)
Cases Where Life Expectancy of Survivors Is Only Half of Average for Their Age Group:	0.527 (0.691)	0.703 (0.808)	0.913 (0.888)

*Results from the Risk-Characteristics Utility Functions are reported in parentheses below the results from the Basic Utility Functions. As expected, there is little difference between the two sets of results. (See the discussion of the Risk-Characteristics Utility Functions accompanying Table 5.)

SOURCE: Charles River Associates, 1984.

As a small initial effort in this direction, we below disaggregate in three different ways the median relative WTP to prevent fatalities due to "cancer from air pollution," as estimated via the Basic Utility Functions:

	Median Relative WTP
Area raised:	
Small town	0.994
Small city	1.244
Large city	1.128
Suburbs	1.059
Highest level of schooling completed:	
College 2 years	1.059
College 4 years	0.999
Masters degree	1.093
Religious background:	
Protestant - fundamentalist	0.765
Protestant - other	1.030
Jewish	1.184
Other	1.000
All respondents:	1.059

The differences in results reported above are from a very small sample totaling only 15 respondents. We have not yet performed formal tests of their possible significance, but it seems likely that most of the differences are not statistically significant by conventional standards.

PART I OF THE QUESTIONNAIRE AND THE RISK-CHARACTERISTICS UTILITY FUNCTION

Various investigators have hypothesized that there are relatively small numbers of characteristics of different risks that largely explain people's relative valuations of programs to reduce them. We can test this hypothesis to some extent with the data from the questionnaire by modifying the list of explanatory variables for the Basic Utility Function in the following fashion:

- Keep the constant term and the categorical variables for sections B through S, life expectancy halved, and ages in the 20's, 60's and 80's.

- Delete the 60 categorical variables for government programs.

- Add the respondents' own "subjective" ratings of the risks which the government programs reduce, from Part I of the questionnaire.
- Add risk characteristics which are "implicit" in the "objective" descriptions of the risks in Part II of the questionnaire.

We now explain the new explanatory variables that are included in the Risk-Characteristics Utility Function but not the Basic Utility Function.

Two risk characteristics for each government program are rated "subjectively" by respondents in Part I of the questionnaire, on an integer scale from one to seven. The first characteristic is the "ease of avoiding the hazard." The specific question asked is as follows: "To what extent is it unreasonably costly, inconvenient or unpleasant for people to avoid exposing themselves to the risk of death from the following hazards?" Low responses ("1" is lowest) indicate "easy and reasonable to avoid." High responses ("7" is highest) indicates "unreasonably costly, inconvenient or unpleasant (or impossible) to avoid." We will sometimes say that high responses indicate a risk is considered to be "involuntary."

The second subjectively specified risk characteristic in Part I of the questionnaire is "personal exposure to the hazard." The specific question asked is as follows: "In the forseeable future, are you likely to be exposed to the risk of death from the following hazards more than the average person? (If your risk-exposure probably will be about average for the U.S. population, mark "4.")" Low responses (down to "1") indicate "I will not be exposed." High responses (up to "7") indicate "I will be exposed much more than average."

Table 4 summarizes the average responses to these two subjective questions on risk characteristics. They follow plausible patterns. The hazards considered on average to be most difficult to avoid are as follows:

(32) Tornadoes	6.2
(45) Job cancer, no information	6.1
(33) Flash floods, travelers	6.0

(The government program number is given first in parentheses above; the average response is given on the right.) The hazards considered easiest to avoid are as follows:

(24) Hair dryers in bathtubs	1.4
(23) Home hair dryer fires	1.5
(17) Cancer from IUDs	1.8
(13) Cancer from smoking cigarettes	1.9

Table 4

AVERAGE SUBJECTIVE RATINGS OF RISK CHARACTERISTICS FROM PART I OF THE QUESTIONNAIRE, FOR 15 RESPONDENTS.

Number for Government Program (Risk Type) and Short Description	Difficulty of Avoiding Hazards	Extent of Personal Exposure
1. Law-abiding drivers	4.7	4.1
2. Speeding by 15 mph	3.2	3.0
3. Speeding by 30 mph	2.3	1.2
4. Speeding by 15 mph, drunk	2.5	1.0
5. Passengers of law-abiding drivers	5.7	3.9
6. Passengers of speeders by 30 mph	2.7	1.7
7. Passengers of regular airlines	5.3	3.7
8. Crews on regular airlines	4.8	1.5
9. People near airport	4.6	1.1
10. People not near airport	5.7	3.3
11. Cancer from air pollution	4.7	4.4
12. Cancer from manmade radiation	4.9	3.9
13. Cancer from smoking cigarettes	1.9	1.5
14. Cancer from illegal dumping	5.0	3.9
15. Cancer from pesticides in foods	4.8	3.9
16. Cancer from artificial sweeteners	2.5	3.0
17. Cancer from IUDs	1.8**	1.5
18. Cancer from river pollution	4.6	3.7
19. Heart attacks	3.7*	3.6
20. Strokes	3.9*	3.5
21. Botulism in canned goods	3.5	3.1
22. Home electrical wiring fires	2.5	3.4
23. Home hair dryer fires	1.5	1.9
24. Hair dryers in bathtub	1.4	1.1
25. Home gas heater fires	2.4	1.4
26. Home Christmas tree fires	2.5	2.3
27. Home lightning fires	5.3	3.7
28. Smoking-in-bed fires	2.3	1.7*
29. Apartment electrical wiring fires	4.8	1.7
30. Office electrical wiring fires	4.7	2.7
31. Night club wiring fires	4.4	1.5
32. Tornadoes	6.2	2.9
33. Flash floods, travelers	6.0	2.9
34. Flash floods, homes	3.7	1.6
35. Lightning striking people	5.1	3.6

Table continued on next page.

Table 4 Continued

Number for Government Program (Risk Type) and Short Description	Difficulty of Avoiding Hazards	Extent of Personal Exposure
36. Beachfront storms	3.0	1.8
37. Policemen	4.3	1.0
38. Coal miners	4.3	1.0
39. Farmers on tractors	3.0	1.1
40. Firemen	4.1	1.0
41. Truck drivers	4.5	1.3
42. Highway construction workers	3.2*	1.1
43. Steeplejacks, etc.	3.9	1.1
44. Movie stunt men	3.7	1.0
45. Job cancer, no information	6.1*	3.4
46. Job cancer, with information	2.7	1.6
47. Alcoholics	2.2	1.2
48. Drug addicts	3.1	1.0
49. Drownings, supervised pool	3.9	2.9
50. Drownings, unauthorized quarry	2.1	1.1
51. Drownings while boating	3.4	3.4
52. Drownings while scuba diving	3.2	1.5
53. Surgery, fatal diseases	4.5	3.6
54. Surgery, severe pain	4.9	3.8
55. Surgery, cosmetic	3.1	1.7
56. Passengers on intercity buses	5.3	3.1
57. Passengers on private planes	2.2	2.0
58. Passengers on railroads	5.1	3.1
59. Motorcyclists	2.2	1.3
60. Bicyclists	4.1	3.3
61. Pedestrians struck by autos	4.6	4.1

*Based on 14 responses.
**Based on 12 responses.

SOURCE: Charles River Associates, 1984.

The hazards to which respondents felt most exposed on average are as follows:

(11)	Cancer from air pollution	4.4
(61)	Pedestrians struck by autos	4.1
(1)	Law-abiding drivers	4.1

The hazards to which respondents felt least exposed include a number of unlikely occupations (for members of the Newton League of Women Voters) and the following:

(4)	Speeding by 15 mph, drunk	1.0
(48)	Drug addicts	1.0
(9)	People near airport	1.1
(24)	Hair dryers in bathtubs	1.1
(50)	Drownings, unauthorized quarry	1.1

We describe below the formal analysis that is based on the numerical responses to Part I of the questionnaire. However, first we note that Part I also was intended to help orient the respondent so that more thoughtful responses to Part II might be obtained. The common ethical touchstone is that "a life is a life," and often there is resistance to thinking in any terms other than those. In fact, a few respondents clung to that simple standard throughout much of Part II. (See Appendix B.) However, most respondents did in fact make many distinctions among the types of risks presented. It may well be that willingness to make those distinctions in Part II is encouraged by the subjective rating in Part I of "involuntariness" and "personal exposure" for the 61 diverse types of risks considered.

Part I of the questionnaire was motivated mainly by the apparent importance of letting each respondent characterize his or her own personal exposure to various risks and his or her own perception of how "involuntary" those risks are. Clearly, the exposure of respondents to various risks differs greatly. For example, some respondents use artificial sweeteners and others do not. (In fact, Government Program 16 has the most widely dispersed subjective ratings in terms of personal exposure.) It also seemed likely that perceptions about the difficulty of avoiding hazards -- such as drug addiction -- would differ importantly across the populations. (In fact, Government Program 48 has the most widely dispersed subjective ratings in terms of difficulty of avoidance.)

On the other hand, perceptions of other potentially significant risk characteristics seemed more likely to be stable across the population, given the descriptions of goverment programs in Part II of the questionnaire. Thus, in the interest of keeping the length of the questionnaire manageable, we specified two risk characteristics only for the statistical analysis. The respondents were never asked about these charactertistics, nor was any information about them explicitly presented in Part II itself (as was information about reduced life expectancy for example). Thus, these risk characteristics are called "implicit-objective," to distinguish them from the "subjective" risk characteristics rated by the respondents themselves (on an arbitrary scale from 1 to 7) in Part I, and to distinguish them from the "explicit-objective" characteristics actually described in Part II.

For the first of these "implicit-objective" risk characteristics, Government Programs 8, 30, and 37 through 46 are characterized as reducing "occupational" risks (by setting a dummy variable equal to one only for those programs). (Government Program 7, which reduces fatalities among passengers of regularly scheduled airlines, seemed ambiguous in this regard, and it was therefore characterized as halfway between being occupational and not.) The second implicit-objective risk characteristic recognizes that, although firemen and policemen may accept the associated risks voluntarily, nevertheless people's WTP for government programs to reduce those risks may be high because other people benefit from their acceptance of the risks. We take into account the possible relevance of these benefits to other people by specifying ("objectively") a dummy variable for firemen and policemen. We judge that none of the other types of risks (government programs) would be nearly so affected by this type of consideration.

RESULTS FOR THE RISK-CHARACTERISTICS UTILITY FUNCTIONS

Table 5 summarizes results from estimating Risk-Characteristics Utility Functions for each of the 15 respondents. (Detailed results for each of the respondents is reported in Appendix B. Summary results for different age groups and for impaired health effects were reported earlier in Table 3, in parentheses below the very similar results from the Basic Utility Functions.)

The two subjectively scaled characteristics in the Risk-Characteristics Utility Function are (1) the difficulty of avoiding the hazard, and (2) the extent of personal exposure. Both are rated on a scale from 1 to 7, as described above. However, since the scales for these variables can differ from respondent to respondent (even for respondents who would rank order the various risks in the same way), the coefficients are not completely comparable. Nevertheless, it is useful to ignore this complication in Table 5 for purposes of summarizing the results from the Risk-Characteristics Utility Functions.

The median relative effect for the subjectively rated "difficulty of avoiding the hazard" is 1.045. This median result means that for each perceived increase of one point in that risk characteristic (on the scale from 1 to 7), the WTP for reduced fatalities increases by 4.5 percent, other things equal. For a hazard rated "7" rather than "1" in difficulty of avoidance, the relative effect is $(1.045)^6 = 1.302$, implying the WTP for reduced fatalities is 30.2 percent higher, other things equal. Qualitatively, this median result is plausible.

Table 5

RISK-CHARACTERISTICS UTILITY FUNCTIONS: RELATIVE EFFECTS OF VARIOUS CHARACTERISTICS ON THE WTP FOR PREVENTING FATALITIES

	Quartiles Across 15 Respondents		
	Lower	MEDIAN	Upper
Subjectively Rated Characteristics (Scale: 1, 2, ..., 7):			
Difficulty of Avoiding the Hazard	0.973	1.045 (t=1.47)*	1.090
Extent of Personal Exposure	1.051	1.159 (t=2.40)*	1.351
Implicit-Objective Characteristics (Equals 0 or 1):			
Occupational Hazards	1.084	1.397	1.517
Firemen or Policemen	1.066	1.128	1.472

*For each respondent a one-sided t-test is performed against the null hypothesis that the indicated subjective risk characteristic (rated in Part I of the questionnaire) has no effect on the WTP for reduced fatalities (as measured in Part II of the questionnaire). The median among those t-statistics is reported in parentheses above. (The median t-statistic does not necessarily come from the same respondent as the median "relative effect" reported just above it.)

SOURCE: Charles River Associates, 1984.

The median relative effect for the subjectively rated "extent of personal exposure" is 1.159. This median result means that for each perceived increase of one point in that risk characteristic, the WTP for reduced fatalities increases by 15.9 percent, other things equal. For a hazard rated "7" rather than "1" in personal exposure, the relative effect is $(1.159)^6 = 2.424$, implying the WTP for reduced fatalities is 142.4 percent higher, other things equal. Qualitatively, this median result is plausible.

In fact, "extent of personal exposure" was estimated to have the expected positive effect on WTP for all 15 respondents. Since each Risk-Characteristics Utility Function is estimated independently, for each respondent an independent one-sided test can be performed against the null hypothesis that personal exposure makes no difference (that is, the relative effect is actually 1.000). Among all 15 respondents, the lowest t-statistic for this one-sided test is 1.30, which is statistically significant at the 10 percent level. As indicated in parentheses in Table 5, the median t-statistic (which does not necessarily come from the same respondent as the median "relative effect" listed above it) for this one-sided test is 2.40, which is statistically significant at the 1 percent level. For 7 out of the 15 respondents, the t-statistic in fact exceeded 3.50, which is extremely significant statistically.

As described above, the median estimated relative effect for "difficulty of avoiding the hazard" is qualitatively plausible. However, this plausible pattern is not exhibited by all 15 Risk-Characteristics Utility Functions. In fact, for 4 of the 15 respondents that risk characteristic was estimated to have a counter-intuitive effect on the WTP to reduce fatalities, as indicated by the lower-quartile estimate of 0.973 reported in Table 5. (See also Appendix B.)

The most plausible explanation for these counterintuitive results from four respondents is collinearity between the two subjectively rated risk characteristics. We have not yet investigated this possibility in detail. In general, considerably more statistical investigation into the relationship between the answers to Parts I and II of the questionnaire will be worthwhile. (For example, an interaction term between the two subjectively rated risk characteristics may be significant for some respondents.)

In the long run, the most desirable solution to multicollinearity between the two subjective risk characteristics would be to augment the list of risk types (government programs) with cases where avoidance is typically (1) difficult but accomplished, or (2) easy but not accomplished. Unfortunately, it is hard to specify risks with this combination of characteristics that are also realistic and important.

This situation points up a general truth: The list of risk types (government programs) this is most useful for immediate policymaking purposes (from the estimation of Basic Utility Functions) may not be the most statistically useful for investigating the importance of underlying risk characteristics. The list of risk types in this initial investigation was selected mainly for immediate relevance to policymaking. However, some less common risks also were included in the hope of improving estimation of the Risk-Characteristics Utility Functions.

The two "implicit-objective" risk characteristics included in our specification of the Risk-Characteristics Utility Function are (1) "occupational hazards," and (2) "firemen or policemen." These risk characteristics are represented by categorical ("dummy") variables, equal to one rather than zero for the indicated cases, so subjective scaling is not an issue. The median relative effect for occupational hazards is 1.379, meaning that the WTP for reduced fatalities is 39.7 percent higher for occupational risks than for non-occupational risks, other things equal. Beyond that, the WTP is 12.8 percent higher if the job is fireman or policeman, based on the median relative effects reported in the last line of Table 5.

There are too few "occupational" and "firemen/policemen" cases in the list of government programs for those characteristics to be statistically significant on many of the individually estimated utility functions. Thus we do not report median t-statistics for those implicit-objective risk characteristics in Table 5, as we do for the subjective risk characteristics. However, results are so consistent across respondents that it is clear that this pattern is highly significant overall. The "occupational" characteristic had a positive effect on WTP for all 15 respondents. All but one respondent attached special additional worth to reducing fatalities among firemen and policemen. (The one exception was by a very small margin and was for the respondent who had the most difficulty understanding the questionnaire, judging from the extent to which her answers were internally consistent. See the discussion below.) This consistency of results across the 15 independently estimated Risk-Characteristics Utility Functions is reflected in the fact that the lower quartiles reported in Table 5 are above one for both "occupational hazards" and "firemen or policemen."

OTHER RISK CHARACTERISTICS

There are a great many risk characteristics that earlier investigators have hypothesized might play an important role in explaining the different values society appears to place on reducing different kinds of risks, but we were unable to include in the present analysis. Slovic, Fischhoff and Lichtenstein have investigated people's perceptions of dozens of risk characteristics in great detail, although their work generally has not attempted directly to measure trade-offs relevent for allocating resources, as we do here. (For useful surveys of their work, including descriptions of numerous potentially relevant risk characteristics, see Slovic, Fischhoff and Lichtenstein, 1981 and 1983.)

Among the numerous risk characteristics considered in earlier studies are some which we would have particularly liked to include on our questionnaire, had not the implied additional response time seemed unreasonably long. Typical hypotheses would be that the perceived value of saving a life from a specified risk is greater to the extent that the following hold:

- The risk is new and unfamiliar.
- Knowledge about the probabilities and consequences of the risks among the exposed population is minimal.
- Exposed persons have very little control over the extent of their exposure, through exercising greater discretion and caution.
- Consideration of the risk tends to raise emotional "dread," rather than calm and objective analysis.
- The total number exposed to the hazard in the United States is large.
- Family and friends are exposed.
- Death is typically accompanied by much pain and suffering.

If there were no constraint on the length of the questionnaire, it would have been useful to include additional questions in Part I that would allow testing of hypotheses such as these. However each additional subjective risk characteristic adds a section to Part I and necessitates 61 additional answers (one for each government program).

In fact, if the effect of many different risk characteristics were to be disentangled, it would be helpful to consider more than 61 different types of risks (government programs), even including some that might be considered unusual or unrealistic. Collinearity among risks would become an even bigger problem than it is for the current version of the Risk-Characteristics Utility Function, as discussed above. For example, the first two risk characteristics listed above undoubtedly are closely related: Risks that are new and unfamiliar tend also to be risks where knowledge about the probabilities and consequences is minimal among the exposed population. (Slovic, Fischhoff and Lichtenstein have analyzed collinearity among groups of risk characteristics in great detail.)

Clearly, considerable judgment was exercised when we chose "voluntariness" and "personal exposure" as the only two subjective risk characteristics to include on the questionnaire. Future investigation may show that other risk characteristics are more incisive, where only a few of these dimensions can be measured.

The analysis of risk characteristics described above is useful, but nevertheless it should be borne in mind that the basic policy-relevant results from Part II of the questionnaire are incorporated in the Basic Utility Functions, which describe trade-offs among the 61 types of risks (government programs) that are explicitly described. Understanding the underlying risk charcteristics that determine these trade-offs should make more reliable the job of generalizing results to other types of risks that are not explicitly described. However, most major types of government health and safety programs are in fact represented on the questionnaire, so this consideration is not necessarily crucial for purposes of guiding actual policy decisions. The Risk-Characteristics Utility Functions estimated for this study must be considered rudimentary, since they include so few of the potentially significant risk characteristics. However, this fact does not detract at all from the validity of the results captured in the Basic Utility Functions.

TRADE-OFF QUESTIONS IN PART II VERSUS CONVENTIONAL DIRECT WTP QUESTIONS

The formulation of Part II of the questionnaire was motivated primarily by a desire to simplify the questions as much as possible, in order to obtain more accurate measurements of respondents' true preferences. A more conventional kind of "contingent valuation" question on the worth of government health and safety measures might have asked: "How much would you be willing to pay to reduce your probability of dying in a motor vehicle accident next year from 0.0002 to 0.0001?"

There are a number of potential difficulties associated with such a hypothetical question as an instrument for measuring respondents' true preferences. We were particularly concerned with two difficulties that seemed most likely to occur: (1) the difficulty of understanding the very small probabilities involved; and (2) the difficulty of fitting the specified risk reduction into the respondents' own "budget constraints" in a realistic fashion.

Most people have only a very hazy notion of the probabilities associated with different kinds of risks they face. And even if they could be made to understand these probabilities, they have little idea what value they generally attach to risk reductions of that magnitude, as one of the many possible expenditures competing for limited resources within their budgets for money, time and effort. Under these circumstances, we suspect that contingent valuation questions of the type illustrated above are often answered with a "worthwhile-cause" response. That is, almost any risk reduction will be worth $5 or $10 or $20 a year, or whatever amount the individual usually allocates to worthwhile causes. This hypothesis about the validity of conventional contingent valuation questions is perhaps somewhat cynical, but, as discussed below, results from Part III of the present questionnaire suggest it may have merit.

The design of Part II of the present questionnaire makes it unnecessary for the respondent to understand small changes in small probabilities, or to budget the implied expenditures on risk reduction, since the questions are couched in terms of trade-offs among government programs. However, Part II at the same time changes the focus of the questionnaire from personal risk reduction (as exemplified by the above "conventional" contingent valuation question) to government programs where everyone pays and many people benefit -- and it does not necessarily overcome a number of other difficulties to which questionnaires are prone. We discuss these matters further below, but first we turn to Part III of the questionnaire, which employs a more conventional type of contingent valuation question, the answers to which can be compared to results from Part II.

PART III: DIRECT WTP QUESTIONS

Part III of the questionnaire in fact retains the focus on government health and safety programs (rather than personal benefits alone) and asks "the maximum amount of additional income taxes your family would be willing to pay, if absolutely necessary" for each of 12 new programs, assuming only one actually will be implemented. The respondent is asked first to assume the government program prevents 10 deaths per year nationwide, and then to assume it prevents 1000 deaths per year. (See Appendix D.)

Respondents in two of the four sample meetings expressed some dismay at attempting to attach a dollar value to government programs that only prevent 10 U.S. fatalities per year, so they were told that the left column in Part III was "optional." Only about half the respondents provided usable answers to those questions.

Among those respondents, only one expressed a WTP to save 1000 lives that was consistently 100 times as great as her WTP to save 10 lives. No other respondent came close to answering Part III of the questionnaire in a manner consistent with the basic assumption we employed to interpret Part II. That assumption requires that the WTP for a government program be proportional to the number of lives saved.

There are two possible conclusions to draw from this pattern of responses to Part III. The first possible conclusion is that the basic proportionality assumption used to interpret Part II does not represent people's true preferences very well, and there is in reality strong diminishing marginal utility attached to life-saving programs (even for programs as small relative to national totals as those specified to save 10 or 1000 lives). However the proportionality assumption is violated so grossly that this explanation is hardly adequate. Seven out of the eight respondents who answered both columns of Part III specified WTPs for preventing 1000 fatalities that were predominantly between 3 and 10 times their WTPs for preventing 10 fatalities. (Even some professional policy analysts who took preliminary versions of the questionnaire answered in this fashion!)

A much more plausible conclusion is that the answers to Part III do not represent very well the "true" preferences which respondents would embrace after extended reflection and analysis. As suggested earlier, the psychological mechanism at work when quick answers must be given to a questionnaire may be somewhat akin to the basis upon which respondents allocate small amounts of money to "worthwhile causes". This "charitable contribution" response plausibly would be insensitive to the numbers of lives specified.

Even if the absolute magnitudes of the WTPs from Part III of the questionnaire have dubious validity, it is still quite plausible that these answers provide information about the trade-offs among different types of governnment programs which is comparable to that from Part II. Hereafter we will focus on the trade-offs (rather than the absolute magnitudes) from Part III, and we will restrict attention to the expressed WTPs for preventing 1000 fatalities, which all 15 respondents provided. (The trade-offs among government programs expressed by those respondents who answered for 10 fatalities as well as 1000 fatalites were usually roughly similar, but maintaining exactly the same proportionality factor between 1000 fatalites and 10 fatalities was the exception rather than the rule.)

Table 6 summarizes the results for 1000 fatalities from Part III of the questionnaire, which we label the "Tax-Payments Utility Function" by analogy with our characterization of the results from Part II. Median answers concerning respondents' "maximum WTP additional taxes to prevent 1000 U.S. fatalities" are presented, along with lower and upper quartiles. The time period (for both the government programs and the additional tax payments) is specified on the questionnaire to be one year, for purposes of specificity and simplicity. However we presume that this consideration was not a significant determinant of the responses. (We worried that 1000 U.S. fatalities might seem unrealistically large for some of the rarer hazards in Part III, such as "policemen." However, respondents appeared to accept the hypothetical nature of the questions and not to worry about that particular irrelevancy.)

The median WTPs to prevent 1000 fatalities reported in Table 6 have roughly plausible absolute magnitudes, compared to results of earlier studies. For such "blameless" fatalities as "law-abiding drivers, passengers on regular airlines, heart attacks, and office electrical fires," the median WTP additional taxes is $10. Taking into account the fact that the median family income of respondents was approximately $55,000, the total additional nationwide tax liability would be roughly 20 or 30 million times as great, implying a value per statistical life of roughly $200,000 to $300,000. (As discussed above, the same calculation based on the answers for preventing 10 fatalities per year would be roughly 10 to 20 times greater.)

Much lower median WTPs are attached to preventing fatalities due to "smoking-in-bed fires, speeding by 30 mph, cancer from smoking cigarettes, home electrical wiring fires, and truck drivers." A somewhat lower median WTP is attached to preventing fatalities among "policemen."

Table 6

TAX-PAYMENT UTILITY FUNCTIONS: MAXIMUM WTP ADDITIONAL TAXES TO PREVENT 1000 U.S. FATALITIES (1984 Dollars)

Number for Government Program (Risk Type) and Short Description	Tax-Payments Utility Function: Quartiles Across 15 Respondents			Comparable Median Results Constructed from the Basic Utility Functions*
	Lower	MEDIAN	Upper	
1. Law-abiding drivers	5.00	10.00	90.00	[10.00]*
3. Speeding by 30 mph	0.00	1.00	15.00	4.77
7. Passengers on regular airlines	2.00	10.00	95.00	10.10
11. Cancer from air pollution	10.00	25.00	150.00	10.59
13. Cancer from smoking cigarettes	0.00	2.00	10.00	3.88
16. Cancer from artificial sweeteners	0.15	2.50	50.00	7.06
19. Heart attacks	3.00	10.00	75.00	9.69
22. Home electrical wiring fires	1.00	2.00	50.00	7.83
28. Smoking-in-bed fires	0.00	0.10	2.00	5.02
30. Office electrical wiring fires	1.00	10.00	60.00	10.00
37. Policemen	2.00	5.00	90.00	9.13
41. Truck drivers	1.00	2.00	35.00	8.85

Table continued on next page.

Table 6 Continued

*As discussed in the text, the Basic Utility Function provides only estimates of the ratios among WTPs to reduce fatalities for the various specified government programs (risk types). The above "comparable median results from the Basic Utility Functions" are constructed from Table 2 by arbitrarily accepting the absolute WTP for "law-abiding drivers" (Government Program 1) from the Tax-Payments Utility Function -- that is, $10.00 per year. This normalization is indeed arbitrary, and any proportional expansion or contraction of the results in this column would be equally consistent with the estimated Basic Utility Functions.

SOURCE: Charles River Associates, 1984.

A much higher WTP is attached to preventing fatalities due to "cancer from air pollution." That median WTP is 2.5 times as great as the median WTP for any other type of risk considered in Part III.

For purposes of comparison, the last column of Table 6 presents comparable WTPs constructed from the Basic Utility Functions described in Table 2, scaling median results so that the absolute WTP for law-abiding drivers matches the $10 WTP from the Tax-Payments Utility Function. There is clearly a significant correlation between the two sets of results. However, the variation in the median WTPs from the Basic Utility Functions is considerably less. This result is particularly striking in the case of "cancer from air pollution," where the Basic Utility Functions imply a median premium of only 5.9 percent over "law-abiding drivers," while the Tax-Payments Utility Functions imply a median premium of 150 percent.

Below we perform further comparisons between the individual respondents' Tax-Payments Utility Functions and Basic Utility Functions. However, even then there is no readily apparent basis for choosing one set of trade-offs in preference to the other, or for combining them in some fashion. This issue deserves much more extensive consideration in the future. One possible procedure would be to mail respondents an analysis of the apparent inconsistencies in their initial responses, and offer them an additional fee if they adjust their answers so they imply the same trade-offs.

VARIABILITY AND CONSISTENCY OF RESPONSES

When this study began, there was some question whether many respondents would find the questions overly sensitive and refuse to answer. Beyond that was the question whether respondents would answer consistently and systematically. In this section we present statistics summarizing the extent to which respondents (1) distinguished among different kinds of risks in Part II; (2) responded consistently for repeated government programs within Part II; (3) exhibited a systematic relationship between the trade-offs in Part II and the risk characteristics rated in Part I; and (4) responded consistently between Parts II and III.

The first two columns in Table 7 (next to the column of respondent numbers) summarize the number and size of the distinctions among the government programs which each respondent made in Part II of the questionnaire. This summarization of the variability of responses in Part II is based on the log of the answers given by the repondents. This "$\log_e N$" is the dependent variable for estimation of both the Basic Utility Functions and Risk-Characteristics Utility Functions, as discussed earlier.

The first measure of variability of responses to Part II is the mean of $\log_e N$, less $\log_e 10$. If all government programs were valued equally in Part II, then all answers would be 10 and the summary measure in the first

Table 7

VARIABILITY AND CONSISTENCY OF RESPONSES

	Variability in $\log_e N$ from Part II		Statistical Significance* of Entire Relationship		Relative WTP from Tax-Payments Utility Function Regressed on Relative WTP from Basic Utility Function		
Respondent Number	Mean $\log_e N$ $-\log_e 10$	Sum of Squared Deviations	Basic Utility Function	Risk-Characteristics Utility Function	Intercept**	Slope**	Statistical Significance* (One-Sided Test)
(1)	0.208	9	0.0001	0.0963	-0.13 (0.29)	1.52 (0.35)	0.0007
(2)	0.274	26	0.0003	0.0001	-0.22 (0.39)	1.20 (0.46)	0.0125
(3)	0.082	3	0.0010	0.0001	-0.85 (0.99)	1.31 (1.03)	0.1165
(4)	1.216	293	0.0005	0.0005 (102 obs.)†	-0.04 (0.12)	0.83 (0.14)	0.0001
(5)	0.154	13	0.0032	0.0002	1.42 (0.93)	-0.65 (0.88)	0.7380
(6)	0.879	114	0.0001	0.0001	-0.14 (0.45)	0.75 (0.48)	0.0742
(7)	0.256	38	0.0001	0.0001 (92 obs.)†	[All 12 government programs valued equally]		
(8)	0.474	19	0.0002	0.0001 (100 obs.)†	-0.35 (0.75)	2.33 (1.05)	0.0258
(9)	1.506	361	0.0001 (101 obs.)†	0.0001 (101 obs.)†	0.32 (0.18)	0.35 (0.17)	0.0343

Table continued on next page.

Table 7 Continued

VARIABILITY AND CONSISTENCY OF RESPONSES

	Variability in $\log_e N$ from Part II		Statistical Significance* of Entire Relationship		Relative WTP from Tax-Payments Utility Function Regressed on Relative WTP from Basic Utility Function		
Respondent Number	Mean $\log_e N$ $-\log_e 10$	Sum of Squared Deviations	Basic Utility Function	Risk-Characteristics Utility Function	Intercept**	Slope**	Statistical Significance* (One-Sided Test)
(10)	0.446	59	0.0001	0.0001	0.31 (0.45)	0.33 (0.50)	0.2626
(11)	0.173	17	0.0037	0.0013 (101 obs.)†	-0.21 (0.58)	0.53 (0.62)	0.2073
(12)	0.956	68	0.0035	0.0004	0.36 (0.18)	0.52 (0.26)	0.0355
(13)	0.211	22	0.0480	0.5501	-0.32 (0.87)	1.80 (1.25)	0.0905
(14)	0.312	17	0.0036	0.0001	-0.29 (0.23)	0.71 (0.26)	0.0105
(15)	0.518	55	0.0001	0.0001	-0.55 (0.87)	2.66 (1.04)	0.0146

*The "statistical significance" level is the probability of obtaining results as extreme as those observed under the null hypothesis of no relationship between the dependent variable and any of the explanatory variables, using standard assumptions for least-squares regression. A two-sided test is employed, except where noted otherwise. (Any probability below 0.00015 is reported here as 0.0001.)

**Estimated standard errors (not t-statistics) are reported in parentheses below the estimated intercept and slope.

†If all questions are answered, the Basic Utility Function and Risk-Characteristics Utility Function are estimated from the 103 responses in Part II. Missing answers in Part II reduce below 103 the number of observations ("obs.") available for both types of utility functions, and missing answers in Part I further reduce the number of observations available for the Risk-Characteristics Utility Function.

column would be zero. By this measure, Respondent 3 made the smallest distinctions among the various types of risks and Respondent 9 made the largest distinctions.

The second measure of variability in responses to Part II is the sum of squared deviations of $\log_e N$ around its mean value. If all government programs were valued eqally, then this summary measure would be zero also. By this measure, Respondent 3 again is identified as the one who made the smallest distinctions among the government programs. (The two measures of variability are not entirely equivalent however. Note for example that the second from the lowest variability according to the "mean" measure in the first column is for Respondent 5, while the second lowest result in the second column is for Respondent 1. Roughly speaking this suggests that Respondent 5 made fewer distinctions than Respondent 1, but when she did make them they were larger.)

The third column in Table 7 summarizes the internal consistency of responses to Part II of the questionnaire, as revealed by estimation of the Basic Utility Functions. (See the general discusssion earlier.) The reported statistical significance is the probability of obtaining results as consistent as those observed, under the null hypothesis of no consistent relationship between the respondent's "true" answers and any of the specified government programs (in those cases where cross-checking is possible). The lower this probability ("statistical significance"), the more consistent was the respondent. All respondents were consistent by this measure at better than a 5 percent level of significance, and only Respondent 13 failed to be consistent at better than a 0.4 percent level of significance.

The fourth column in Table 7 reports the statistical significance of the entire Risk-Characteristics Utility Function. Roughly speaking, in comparison with the Basic Utility Function these results will tend to be more significant because there are fewer explanatory variables (implying more "degrees of freedom"), but they will be less significant if the limited menu of risk characteristics ("personal exposure," etc.) fails to capture adequately the considerations which the respondent feels are important. In addition, estimation of the Risk-Characteristics Utility Function will tend to be damaged by any inaccuracy in the responses to either Part I or Part II of the questionnaire. (Estimation of the Basic Utility Function provides a check on the consistency of responses to Part II of the questionnaire, but other possible kinds of inaccuracies in Part II are not detected by this test.)

For all but two of the respondents, the Risk-Characteristics Utility Function is highly significant statistically, at better than the 0.2 percent level. Respondent 13 again provided the least statistically significant results, by a wide margin. (The respondent number was assigned chronologically, before the quality of responses had been analyzed.) More detailed examination of the questionnaire of Respondent 13 reveals that most of her answers followed a pattern that was not remarkable, but there were a few unexplained quirks that apparently destroyed the significance of the Risk-Characteristics

Utility Function. For example, she attached quite low relative WTPs to "tornadoes" and "home lightning fires" (Government Programs 32 and 27 respectively) in Part II, despite the fact that she plausibly identified these hazards in Part I as most difficult to avoid. Other of her answers to Part II also suggest she may have been affected by the rarity of hazards in the questionable way discussed earlier (in the context of Table 2). Also, in Part I a number of her ratings were dubious. For example, death for "law-abiding drivers" was rated as least difficult to avoid, while death for "[law-abiding] truck drivers" was rated as most difficult to avoid. Nevertheless, the majority of her answers appeared reasonable, and it may be that a robust estimation method, less sensitive to outliers than Ordinary Least Squares, might have judged her answers to be more systematic.

As noted earlier, concern about outliers was the motivation for summarizing results across all 15 respondents in terms of the median and upper/lower quartiles (rather than in terms of the more conventional average, standard deviation, and skewness measure). With 15 respondents, the upper and lower quartiles are completely unaffected by the extremeness of the three highest and lowest values. The significance levels reported in the third and fourth columns of Table 7 certainly suggest that a sufficient number of respondents were providing consistent and plausible responses so that the median (and quartiles) should provide high quality estimates of central tendencies. (In principle, some information relevant for social decisionmaking is lost by using median WTPs rather than average WTPs, particularly where the unobserved true WTP distributions are highly skewed (which may well be the case, where the distribution of income and wealth is highly skewed). However, we judge insensitivity to outliers to be the more important consideration for present purposes. This issue deserves somewhat more detailed analysis before final results from this study are utilized for policy decisions.)

One reason for performing the individual statistical tests described in the third column (and, to a less extent, fourth column) of Table 7 is to detect respondents who are not being conscientious and careful, perhaps because their only motivation is to earn the fee given to respondents. There was no indication that any of the respondents in the present experimental samples (even Respondent 13) were not trying to do a good job. However, when future versions of the questionnaire are administered to more heterogenious samples, this consideration may become more relevant.

The last three columns of Table 7 compare for each respondent the relative WTPs from the Tax-Payments Utility Function (from Part III of the questionnaire) with the corresponding results for the Basic Utility Function (from Part II). (See also the comparison of median results for all 15 respondents presented in the last column of Table 6.) In particular, relative WTPs were calculated from Part III using "law-abiding drivers" as the numeraire for each respondent, and the resulting 12 relative values were then regressed on the relative WTPs for the same 12 government programs from

Part II. If results from Part III of the questionnaire perfectly matched those from Part II for a particular respondent, then the regression should have an intercept equal zero and a slope equal one (as well as a statistical significance level approaching zero).

Respondent 4 comes closest to this ideal. Altogether, 14 of the 15 respondents exhibited the expected positive correlation between the results from Part III and Part II, though not always at a high level of statistical significance. (Note that the statistical significance levels reported here are not easily comparable in any meaningful sense to those for the Basic Utility Functions and Risk-Characteristics Utility Functions reported in the third and fourth columns of Table 7, if only because there are only 12 observations in Part III of the questionnaire versus 103 observations in Part II. Note also that there is no way to test internally for consistency of responses in Part III, as there is in Part II.)

Respondent 5 is an interesting case. Throughout most of Part II, including most of the programs later included in Part III, she made few distinctions among the government programs (apparently assuming "a life is a life"). Yet, when she got to Part III she was willing to attach very low WTPs to "speeding by 30 mph, home electrical wiring fires, truck drivers, and [especially] smoking-in-bed fires." The result is a statistically insignificant negative correlation between the two sets of results. It is not clear whether Respondent 5 changed her mind about the general validity of the life-is-a-life principle in the course of answering the questionnaire, or just found it easier to make distinctions among risk types in Part III. Perhaps if she had answered Part III before Part II, an entirely different pattern of responses would have emerged. Fortunately, this degree of inconsistency of responses between Parts II and III of the questionnaire is the exception rather than the rule, though there certainly are sufficient discrepancies to warrant further investigation before opting entirely for one set of results in preference to the other, or combining them in some way. The most notable difference, as noted earlier, is the greater variability of responses to Part III.

OTHER PROBLEMS WITH QUESTIONNAIRES

In addition to the difficulties with questionnaires discussed above, there are numerous other potential pitfalls associated with measuring individuals' true preferences by this means. The danger of strategic responses has received considerable attention in the theoretical literature. This theory has intriguing features, but it probably is not very relevant for the case at hand. After completing the questionnaire, respondents were asked about the possibility of strategic responses. The typical reaction was amusement. Most respondents plausibly claimed that the questionnaire asked about issues that they had not considered previously in such terms, so they had very little idea what government programs would need to be expanded or contracted to conform better to their preferences, or how their preferences compared to those of the average respondent. Under these circumstances, strategic behavior is unlikely, even without relying on the manifest honesty and goodwill of the respondents.

However, one respondent did remark that she already had analyzed the issue of additional medical aid for alcoholics, and had concluded it was worthwhile because it was so cheap to provide. She worried that the lesser weight given on her questionnaire to saving the lives of alcoholics would lead to a policy conclusion with which she disagreed. She was told that cost information later would be compared with the preferences expressed on the questionnaire in order to reach a final policy recommendation, and if helping each alcoholic were indeed inexpensive then the appropriate conclusion would be reached.

Several respondents remarked or agreed that their numerical responses might change significantly if they had had much more time to consider the difficult moral judgments involved. In the future it might be worthwhile to give respondents copies of their completed questionnaires and allow them to send back edited "final judgments" after a week. It would then be possible to determine whether these changes tended to follow any consistent pattern across individuals. The research of Slovic, Fischhoff and Lichtenstein (see for example their 1982 survey article, pages 11-21) suggests that values concerning such difficult issues tend to be "uncertain and labile," so it would not be surprising if significant changes often were made.

The research of Slovic, Fischhoff and Lichtenstein also emphasizes the importance of the "decision frame" in determining what preferences are expressed -- particularly where hypothetical questions are involved. One simple but potentially significant issue in this regard is the choice of "10 lives saved" as the benchmark for the most worthwhile government programs in Part II of the questionnaire. Unfortunately, it cannot be taken for granted that essentially the same WTP ratios would have resulted if "1 life saved" or "100 lives saved" had been used as the benchmark. It would be worthwhile eventually to experiment with a number of such plausible variations on the questionnaire.

There is no easy way around the uncertainties and difficulties noted above. The most useful general strategy is to try a variety of different instruments and survey strategies, note any differences in estimates which emerge, and attempt to choose the most reliable results or otherwise reconcile the differences. Part III of the questionnaire was in large part originally motivated from this perspective.

WTP FOR GOVERNMENT PROGRAMS VERSUS WTP FOR PERSONAL BENEFITS

As noted earlier, the questionnaire used in this study differs from more conventional attempts to elicit WTPs for health or safety measures in that it asks about government programs rather than benefits received by the individual respondent alone. Where a questionnaire asks about WTPs for personal benefits alone, the corresponding social choice criterion is conventionally the average (or total) WTP across the population. WTPs for government programs, as investigated in our questionnaire, plausibly may differ significantly from WTPs for personal benefits alone, due to considerations such as the extent to which the respondent "altruistically" takes into account the costs and benefits of the government program for other people.

Appendix A addresses this issue, first from the perspective of how the two kinds of WTPs are likely to be related to one another, and finally from the perspective of which average WTP is the preferable criterion for social choice. The bulk of Appendix A speculates about the statistical issue of how the WTP for a government program and WTP for personal benefits alone are likely to differ, especially in terms of the social averages which could serve as criteria of social choice. The conclusion is that the social averages may not differ very much, even if the two kinds of WTP differ substantially at the individual level. The analysis is based upon assumptions about the joint distribution of (1) "exposure," (2) "altruism," and (3) "income" across the relevant population.

Without being precise here about the definitions of these concepts, we give the flavor of the results in Appendix A by noting that either of the following is a sufficient condition for these two kinds of WTPs to have the same societal average:

- exposure is uncorrelated with both altruism and income (which may be correlated); or
- altruism is uncorrelated with both exposure and income (which may be correlated).

In either of these cases, the differences at the individual level between the "WTP for the government program" and the "WTP for personal benefits alone" exactly average to zero across the population.

Appendix A concludes that the most likely major cause of a difference between the societal averages is a correlation between exposure and altruism (even if income is uncorrelated with both). In particular, it is plausible that people who are heavily exposed to a particular risk will want extensive government programs to reduce that risk, without worrying very much about whether other people are paying more taxes for the program than the associated benefits are worth to them. On the other hand, people who are not exposed at all to the risk nevertheless may be willing to support significant governmental programs, out of a sense of "altruism" according to our terminology. In this type of situation, the societal average "WTP for the government program" will tend to be greater than the societal average "WTP for personal benefits alone."

It will take more extensive investigation than that allowed by the present questionnaire in order to attempt to estimate quantitatively the extent to which there is a difference between the societal averages of the two kinds of WTPs. Supposing for the sake of argument that the two societal averages do in fact differ significantly, the issue then becomes choosing the preferable social choice criterion. There does not seem to be a simple answer to this question.

Consider in particular the suspected situation described above, where a negative correlation between exposure and altruism causes the societal average WTP for a government program to exceed the societal average WTP for personal benefits alone. One way to view this situation is that the exposed-nonaltruistic people are "taking advantage" of the nonexposed-altruistic people, allowing total taxes to exceed the amount justified by the total utility received from personal benefits. From that perspective, the preferred social criteria would be the average WTP for personal benefits alone.

The alternative interpretation is that some people receive additional utility from seeing the costs and benefits of government programs match for other people, and this additional utility is effectively equivalent to the utility they receive directly from the personal benefits of government programs. This effect can vary depending on the type of risk under consideration, so that people receive the most additional utility from seeing other people protected from "the right kind of risks" -- such as "involuntary" risks. From that perspective, it could be argued that some importance should be attached to the societal average WTP for a government program, as distinct from the societal average WTP for personal benefits alone.

We do not attempt here to resolve these fundamental issues concerning how social choices should be made. However, we do conclude that the type of questions employed in this study can provide useful information, despite the fact that a desire for simplification has led us to measure WTP for government programs rather than WTP for personal benefits alone.

LESSONS FROM ADMINISTERING THE QUESTIONNAIRE

The survey instrument reproduced in Appendix D probably should not be administered without supervision. The majority of respondents were able to accept the hypothetical nature of the questions and follow instructions without coaxing. However, some respondents needed encouragement and guidance.

The initial experimental samples identified a number of minor ambiguities in the questionnaire, some of which were noted in the course of earlier discussions. These ambiguities were discussed verbally in the sample meetings. Most can be reduced by rewording the questionnaire or editing it in other ways. One conclusion is that specifying hazards about which there is still scientific uncertainty -- such as cancer from intrauterine devices (Government Program 19) -- causes more trouble than it is worth for the immediate purposes of the questionnaire.

It would probably also be helpful to make more vivid in Part II the balancing of different numbers of beneficiaries of the government programs. A graphical device picturing different numbers of beneficiaries of the government programs might help respondents avoid attaching too little importance to preventing fatalities due to "rare hazards," as discussed earlier in the context of Table 2.

There was some initial concern that comparing ten government programs at one time in Part II (as required in Sections H and N) would be too difficult. However, no respondents mentioned that they found the longer sections in Part II significantly more difficult than the shorter sections. The first step in responding to a section in Part II involves "checking off" the most worthwhile of the government programs, and this procedure apparently was successful in orienting respondents and providing a basis for comparing a substantial number of less worthwhile programs.

As expected, within each questionnaire the ratings of many of the government programs in Part II tended to be the same. This situation was one major reason that numerical responses were requested in Part II, rather than some type of ranking. Ranking procedures become inordinantly difficult when the respondent's preferences indicate many "ties" and "near-ties." Other considerations arguing in favor of numerical responses are the greater amount of information obtained per response and the correspondingly greater simplicity of the statistical methods required. This choice of technique appears to be one of the most successful aspects of this study.

AREAS FOR FUTURE WORK

Many areas for future work were mentioned above, in the context of related results from the experimental samples. The most obvious such area is to refine the questionnaire based on experience with the experimental samples, and then to apply it to enough people to obtain results reasonably representative of the whole population of U.S. voters. It may never be possible to refine the questionnaire sufficiently so that it can be administered without supervision (by mail, for example), but it should be possible to come somewhat closer to a self-explanatory instrument.

Since a large amount of data is gathered by each questionnaire, even data from 15 respondents would support considerably more statistical investigation than that undertaken for this report. There are potentially useful further ways to compare the answers to Part III ("Tax-Payments Utility Function") and Part II ("Basic Utility Function"). The Risk-Characteristics Utility Function (based on Parts I and II) offers particularly extensive opportunities for additional statistical investigation with the existing dataset. Different functional forms (such as interaction terms) and additional ("implicit-objective") risk characteristics specified by the investigator could be tried. The apparent collinearity between the subjectively rated "personal exposure" and "voluntariness" deserves further consideration.

One complication we did not mention in the previous text is the possible importance of the choice of the numeraire hazard. At the level of the individual respondent, the choice of the numeraire to be law-abiding drivers is indeed "arbitrary," and it is easy to transform a given set of results from one numeriare to another without loss of information. However, summary results for the whole sample are not invariant in this way to the choice of numeraire. The "median relative WTPs" can depend on the choice of numeraire. The possible importance of this issue can be investigated empirically, simply by trying different numeraires and seeing how much difference it makes in the resulting median ratios. Additional theoretical analysis may suggest a formal procedure for choosing a "best" numeraire -- perhaps the risk type about which respondents "agree most" in some sense.

It may be worthwhile also to recognize more extensively the apparent differences in the quality of responses received from different respondents. Straightforward calculations of quartiles (or means and standard deviations) does not recognize differences in the internal consistency of the answers of different respondents, though quartiles are presumably more robust in the presence of such inconsistency since they are insensitive to outliers. In the limit, it may be desirable to have a formal criterion for disgarding questionnaires where responses are insufficiently consistent, suggesting the respondents were unable or unwilling to provide the requested information about their preferences. The estimated standard errors on the coefficients of the Basic Utility Function (not discussed in this report) are presumably the appropriate information upon which to base such an improved method of estimating the central tendencies from the entire sample.

Considerably more could be said about the rationale for employing the type of questionnaire used in this study, and how it relates to previous investigations of the characteristics of various risks and the importance which society attaches to reducing them. It was almost unavoidable to mention the work of Slovic, Fischhoff and Lichtenstein in the course of our discussion. However, there are a substantial number of other studies which deserve to be identified as antecedents of our current efforts.

The general relevance of the results of this survey to allocating government resources among health and safety programs is apparent. However, application of the results will involve further nontrivial analysis. As a simple example, the benefits of any particular highway safety program must be allocated among the questionnaire's eight hypothetical government programs that prevent different kinds highway fatalities. It would be worthwhile to analyze further such practical aspects of applying our results, at least in general terms.

There is a large economic literature on social choice criteria and related topics whose relevance to the issues addressed in this study has not yet been fully exploited. Existing conceptual studies of "demanding-revealing mechanisms" and "altruism" promise to suggest more incisive variations on the existing questionnaire, and more incisive ways to utilize for policy analysis the resulting relative valuations of government programs. There are particularly significant relationships between existing literature on "altruism" and the discussion in Appendix A on the WTP for government programs versus the WTP for personal benefits alone. Further investigation of this literature promises a deeper conceptual foundation for the present study and any future extensions.

The most obvious directions in which to expand the scope of the present questionnaire are to include non-fatal injuries and illnesses, and to include children. The extension to non-fatal injuries or diminished health would require precise descriptions of those conditions, which promises to be difficult. However, conceptually that extension is straightforward. Considering children would require measuring new risk characteristics, since, for example, a risk which is easy for an adult to avoid may be more difficult for a child to avoid (e.g., being the passenger of a speeding driver).

Differences between results from Parts II and III of the present questionnaire suggest clearly that the way in which questions are asked (and perhaps even the order in which they are asked) can have a significant effect on the results obtained. It would be worthwhile to try a number of plausible variations on the questionnaire in the future, to test the sensitivity of results to such apparently nonsubstantive changes as using 100 fatalities rather than 10 fatalities as the basis of comparison in Part III. Considerably more effort should go into reconciling any differences in responses that result from different ways of "framing" the questions. Probably the best technique is to interview respondents additional times, and see if they are willing to reconcile any major inconsistencies in their answers that are attributable to variations in framing (or other causes). Just having additional time for reflection may induce some respondents to change their initial answers, even if they were originally consistent.

A somewhat subtle "framing" issue concerns the structure of Part II of the questionnaire, in particular the linkages and cross-checking among the 19 sections that are effected by repeating government programs. Under the null hypothesis that the choice of linking government programs has no effect on the results, residuals from the estimated Basic Utility Functions (which can be nonzero for repeated government programs) should tend to average zero across the population. If residuals for particular questions in Part II tend to be consistently positive or negative, it would indicate that this null hypothesis should be rejected. Further investigation with alternaitve structures might then be warranted. (Similar detailed analysis of the residuals from the Risk-Characteristics Utility Functions would be useful also.)

We are not immediately hopeful about designing questions which will elicit realistic absolute WTPs for government programs, as Part III of the questionnaire ostensibly attempts to do. However, the relative WTPs derivable from Part III appear to be worth considerably more extensive investigation. Taking into account also the unease among respondents apparently caused by the two columns of Part III, it may be preferable to delete the column for 10 fatalities and expand the column for 1000 fatalities to include more types of risks. (It would also be useful to have some redundancy and cross-checking in Part III, but it is not obvious how to accomplish this in a plausible fashion.)

The main limitation in our study resulting from restricting the size of the questionnaire is in the number of risk dimensions which were investigated. If samples were drawn from a population with low opportunity costs and high tolerance for a long and complicated questionnaire (such as college students?), it might be worthwhile to rank subjectively more risk characteristics and expand the list of government programs. We do not attach highest priority to this extension of our work, because the Basic Utility Functions are more directly relevant to policymaking than the Risk-Characteristics Utility Functions. However, it might be particularly useful to add a few government programs to the questionnaire which would help break the collinearity between "personal exposure" and "involuntariness."

A particularly ambitious direction in which to extend our investigation would be to attempt to measure respondents' WTP for personal benefits alone, as well as their WTP for government programs. One possible approach to doing this would be to attempt to measure perceived "personal exposure" on an explicitly cardinal probability scale relative to some numeraire (rather than just on the subjective scale of 1 to 7 used in the current version of the questionnaire), and then to assume that respondents wish to minimize their overall probability of dying, regardless of the cause. This approach could in principle still avoid the difficulty of attaching realistic absolute dollar values to small changes in small probabilities of dying from various causes.

The theoretical mirror image of a questionnaire on Willingness to Pay for additional government health and safety programs is a questionnaire on Willingness to Accept [Payment] for cutbacks in those programs, implying larger numbers of fatalities from various hazards. We suspect this perspective would make respondents less cooperative so we are not particularly anxious to try it, though it could be an interesting experiment.

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APPENDIX A

WILLINGNESS TO PAY FOR A GOVERNMENT PROGRAM VERSUS WILLINGNESS TO PAY FOR PERSONAL BENEFITS ALONE

The questionnaire we use in this study to investigate people's preferences regarding government health and safety programs is somewhat unconventional. Perhaps the most significant novel feature is the fact that the questions ask (explicitly or implicitly) about maximum "willingness to pay" ("WTP") for government health and safety programs that potentially affect everyone in society, in terms of both benefits received and additional taxes paid. The more conventional approach is to investigate WTP for personal benefits alone, and then to treat society's total (or average) WTP for personal benefits as the appropriate benefits criterion for comparison with the actual costs of the program. This appendix thus focuses on the likely determinants of differences between society's average WTP for a government health and safety program and society's average WTP for personal benefits alone. We ultimately ask which of these is the preferable social criterion.

We assume that the crucial difference between expressing a maximum WTP for a government health and safety program and making a personal consumption decision is that, in the first case, one is contributing to a collective decision that will force everyone in society to pay additional taxes and potentially will provide benefits to everyone. Conventional welfare economics assumes individuals' utility functions are independent, and from that perspective it is hard to rationalize a difference between WTP for a government program and WTP for the personal benefits of the program. However, in fact many people do appear to attach some importance to changes in the welfare of others in society -- in this case welfare changes due to the difference between the benefits and costs of the proposed government program for other people. Our analysis allows for this additional consideration in the determination of the WTP for a government program, generally characterizing it as "altruism."

We omit from this appendix a number of complications that are not crucial to the main arguments. Some people have a philosophical bias against being forced into collective decisions, but we do not explicitly allow for such preferences. Our analysis of government programs is built up basically from information about how individuals would behave if the benefits of the program were provided at some price by the private market, rather than being provided as a public good. We also do not consider explicitly cases where government regulations force more of the cost of a program to be borne by its beneficiaries (though it would not be difficult to extend the analysis to that situation). Our arguments are couched in terms of the simplest type of policy decision, where there is a single independent option about which a simple decision of yes or no must be made. We do not explicitly analyze cases where the extent of the government program, or its implications for the costs or benefits of other potential government programs, must be considered. We also do not consider problems of sampling error, often speaking as though the entire population were being surveyed. In the main we assume that responses to questionnaires adequately reflect people's true tastes.

SUMMARY

We now summarize our major arguments and conclusions. To begin (and through the longest and most detailed portion of the appendix), we accept the conventional assumption that society's total (or average) WTP for personal benefits is the appropriate benefits measure for government health and safety programs. In fact, we extend the applicability of that concept by assuming that the average WTP for personal benefits of other people is the appropriate basis for explaining and predicting whatever altruism enters an individual's statement of WTP for a government health and safety program. A purely altruistic WTP for a government program is defined as one which implies tax increases that on average would equalize everyone's WTP for personal benefits and their additional taxes, assuming everyone's taxes increase by the same proportion. The purely altruistic respondent is allowed to take into account the fact that his income (more specifically, his orgininal tax level) is lower or higher than average, but he is assumed not to take into account additional considerations, such as the extent of his own personal exposure to the risks which the government program reduces.

One immediate implication of this definition of altruism is that the altruistic WTP may be either higher or lower than the WTP for personal benefits alone. For example, the altruistic respondent who is highly exposed to a hazard is assumed to lower his stated WTP for a protective government program, because he realizes that the implied tax increases would exceed most people's wTP for personal benefits alone. Moreover, even recognizing that the extent of altruism differs across individuals (and across types of government programs), it is entirely possible that society's average WTP for a government program will differ little from society's average WTP for personal benefits alone.

We formally analyze the conditions under which society's average WTP for a government program (as measured for instance by Part III of this study's questionnaire) will equal society's average WTP for personal benefits alone. Our analytical framework distinguishes variables that measure across individuals the following three characteristics:

(1) their original *tax level*;

(2) the extent of their *exposure* to the relevant hazard (measured in terms of the proportionate tax increase they would be willing to pay); and

(3) the extent to which their stated WTP for a government program incorporates *altruism*.

The conditions we investigate thus depend on the joint probability distribution of original *tax levels* (we often say "income" for simplicity), *exposure*, and *altruism*.

For a particular government program under consideration, society's average WTP for the program will *exactly equal* society's average WTP for personal benefits alone if *either* of the following two conditions is met:

- *Exposure* is distributed independently of *income* and *altruism*; or
- *Altruism* is distributed independently of *income* and *exposure*.

(These are each sufficient but not necessary conditions.)

If *income* is distributed independently of *exposure* and *altruism*, correlation between *exposure* and *altruism* can still cause a difference between society's average WTP for a government program and society's average WTP for personal benefits alone. In general, such correlation between *exposure* and *altruism* appears to be the most important reason for these two societal averages to differ significantly, even in situations where *income* (original tax level) is not distributed independently. We hypothesize that for most government health and safety programs *exposure* and *altruism* will tend to be *negatively* correlated, causing society's average WTP for the government program to exceed society's average WTP for personal benefits alone. (For *different government programs*, the univariate distribution of income across the population will be the same; however, the distribution of *exposure* to the relevant hazard will certainly differ, and, we argue, the extent of various individuals' *altruism* is likely to differ as well.)

We develop in detail the special case where income is distributed independently, since the simplicity of the case allows a more intuitive and definite analysis of the implications of correlation between exposure and altruism. In this case, perfect negative correlation between exposure and altruism can, in the extreme, cause society's average WTP for a government program to be twice as large as society's average WTP for personal benefits alone. However, we argue the actual difference between the two benefits criteria is likely to be much less than that in realistic situations.

We develop numerical examples (using simple one-trial binomial distributions) to illustrate our concepts and results. We also consider briefly the implications of discounting the effect of income distribution on the social benefits criterion, and on the way in which individuals formulate their altruistic WTPs. We present the simple limiting case where the only relevant consideration is assumed to be the proportions by which taxes would increase, regardless of the absolute levels of income (taxes) for various individuals.

Our major conclusions from this analysis are as follows. As a benefits criterion, society's average WTP for personal benefits alone does not appear to capture adequately the importance most people attach to the distinction between largely involuntary hazards, such as air pollution, and other hazards that are easier to avoid, such as those associated with smoking or reckless driving. Society's average WTP for a goverment program, incorporating altruistic effects (i.e., allowing for interdependence of utility functions among members of society), more fully captures these considerations and may well come closer to the benefits criterion most people think appropriate. Thus, a difference between the two benefits criteria does not necessarily imply that the average WTP for a government program is inappropriately biased. As a practical matter, the two societal averages may not in fact differ very much.

Our questionnaire's focus on WTP for a government program allows simpler, more comprehensible questions, and a more realistic context (similar to a voting situation) which seems more likely to elicit respondents' true preferences. Future studies, asking explicitly about both WTP for government programs and WTP for personal benefits, may allow more definitive conclusions about the importance of the distinctions we have made. However, it would have been overly ambitious to attempt to resolve all these issues in our first empirical study.

INDIVIDUAL WTP FOR PERSONAL BENEFITS ALONE AND THE IMPLICATIONS OF ALTRUISM

We start by taking as given information the maximum "willingness to pay" ("WTP") of each respondent for the benefits of the government program that he or she receives personally. At only a few points in our analysis will we stop to consider, briefly and qualitatively, the utility maximization that presumably underlies the determination of this value. Also, only near the end of this appendix will we briefly consider the very real possiblity of significant differences between the responses to a questionnaire and a person's true WTP. These issues are potentially very important, but the questions we address in this appendix are sufficiently narrow that, to a large extent, we need not consider in detail respondents' utility functions or possible biases in responses to a questionnaire.

Let W_i^* be the WTP of respondent i for the personal benefits of the government program under consideration, and let fraction a_i be the relative increase in the respondent's original tax liability T_i that W_i^* represents:

$$W_i^* = a_i T_i \qquad \text{(A-1)}$$

If the government program were to be provided to all members of society, while taxes were generally increased by fraction a_i, typically most members of society (other than respondent i) would end up with increased tax liabilities different from their WTPs for the personal benefits of the government program. For example, for respondent j ($j \neq i$), it would typically be the case that $W_j^* \neq a_i T_j$. Averaging over all members of society, it would also typically be the case that

$$\underset{j}{E}(W_j^*) \neq \underset{j}{E}(a_i T_j) \qquad \text{(A-2)}$$

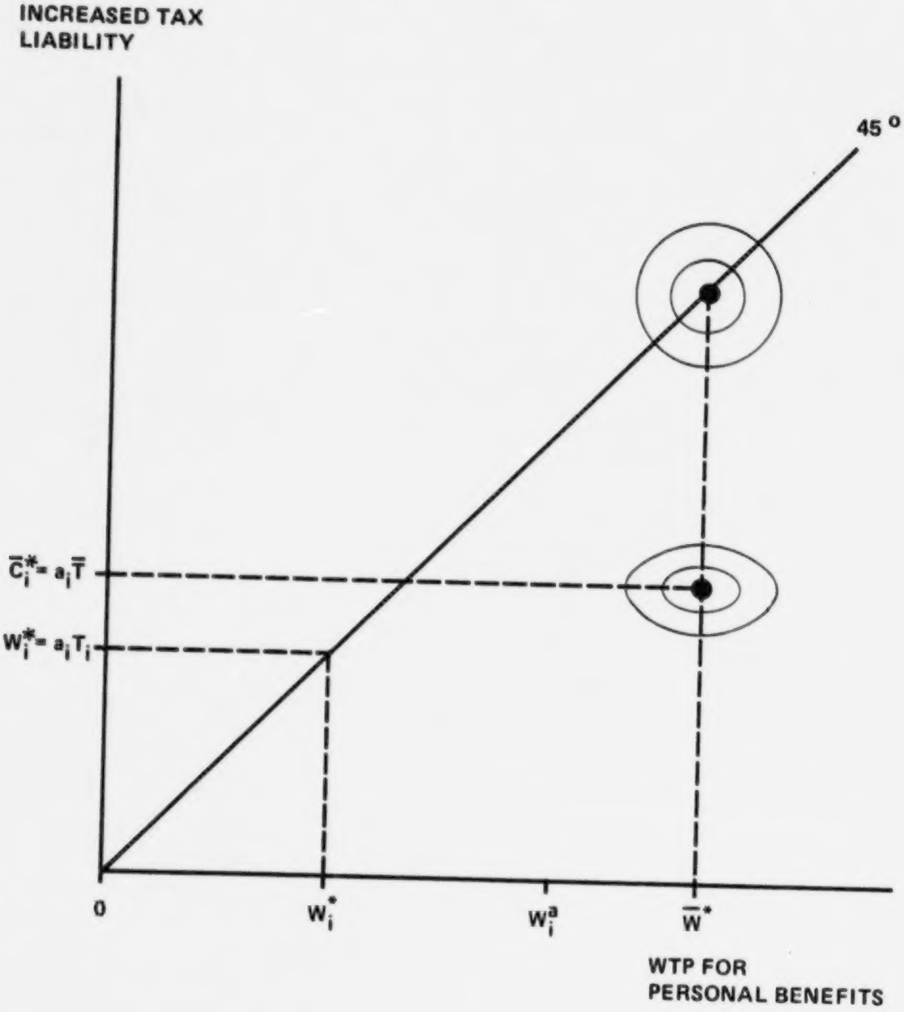
(where the expectation operator E applies here only to the indicated index). Using bars to indicate population means of individual random variables, and making the index subscript j implicit rather than explicit, typical inequality (A-2) is stated more simply as

$$\overline{W}^* \neq a_i \overline{T} \quad . \qquad \text{(A-3)}$$

These concepts are illustrated graphically in Figure A-1. The WTP for personal benefits of respondent i (W_i^*), as well as the corresponding WTPs for others in society, is measured along the horizontal axis. The increased tax liability for respondent i is measured vertically to equal his W_i^*, using the explicit 45° line. For all individuals in society, the joint distribution of WTP for personal benefits W^* and implied tax liability increase $a_i T$ (using proportion a_i appropriate for respondent i) is

Figure A-1

THE JOINT POPULATION DISTRIBUTION OF WILLINGNESS TO PAY (WTP) FOR PERSONAL BENEFITS AND INCREASED TAX LIABILITY, IMPLIED BY THE WTP FOR PERSONAL BENEFITS OF RESPONDENT i


INCREASED TAX LIABILITY
45 °
$\bar{C}_i^* = a_i\bar{T}$
$W_i^* = a_iT_i$
0
W_i^*
W_i^a
$\bar{W}^*$
WTP FOR PERSONAL BENEFITS

NOTATION: W_i^* = WTP for personal benefits of respondent i

T_i = Original tax liability of respondent i

a_i = Implied tax liability proportion for respondent i

$\bar{T}$ = Average original tax liability over the population

$\bar{C}_i^*$ = Average increased tax liability for the population implied by a_i

$\bar{W}^*$ = Average WTP for personal benefits over the population

W_i^a = Purely altruistic WTP of respondent i

SOURCE: Charles River Associates, 1983.

represented in Figure A-1 by the distribution's equal-probability contours. For simplicity, these contours are drawn symmetrically (as flattened concentric circles) so their center point is the point of joint means $(\overline{W}^*, a_i\overline{T})$. (Ignore the concentric circles on the 45° line for the moment.)

For convenience, we use the single symbol $\overline{C}_i^*$ for the average additional tax liability ("cost of the government program") for all members of society, if taxed the additional proportion a_i appropriate for the WTP for personal benefits of respondent i:

$$\overline{C}_i^* = a_i\overline{T} \qquad \text{(A-4)}$$

Figure A-1 thus represents the implications of the individualistic preferences of respondent i for the rest of the population. The figure is drawn for a case where respondent i is willing to pay considerably less than the average member of society for the personal benefits of the government program: $W_i^* < \overline{W}^*$. The figure in fact provides a basis for "explaining" $(W_i^*/\overline{W}^*) < 1$, by decomposing the fraction into two factors. In particular, for respondent i

$$(W^*/\overline{W}^*) = (W^*/\overline{C}^*)(\overline{C}^*/\overline{W}^*) \qquad \text{(A-5)}$$

(where the index i is left implicit).

We call the first of these factors the "income effect," because

$$(W_i^*/\overline{C}_i^*) = (a_iT_i)/(a_i\overline{T}) = T_i/\overline{T} \quad . \qquad \text{(A-6)}$$

This fraction is below one in Figure A-1, implying that respondent i has a tax liability (and hence, we will often say, an income) that is below average.

The second factor in relationship (A-5) is $(\overline{C}^*/\overline{W}^*)$. It is also below one in Figure A-1, indicating that the majority of people would be willing to pay a greater proportionate tax increase than respondent i in order to receive the personal benefits of the government program under consideration. We call this second factor the "exposure effect." (Though $(\overline{C}^*/\overline{W}^*) < 1$ may be commonly due to the fact that respondent i is "less exposed" to the relevant hazard than other people, a host of further considerations would enter into a more profound analysis of this factor. For example, one consideration might be whether the respondent feels (more than others) that dying from the relevant hazard is particularly glamorous or painless. More generally, all the characteristics of the respondent that cause differences among utility functions (such as the size of the family to be supported) will affect his WTP for all goods and services, including an additional health or safety measure.)

The main reason that the above decompositon of relative WTP for personal benefits ($W^*/\overline{W}^*$) is useful is that it suggests a reasonable working definition of what would constitute an *altruistic* response, where a government program helps all exposed people and everyone's taxes increase by the same proportion. Supposing that respondent i has some comprehension of others' average WTP for personal benefits ($\overline{W}^*$) and others' average original tax liability ($\overline{T}$), we define a *purely altruistic WTP (Wa)* as one *determined solely by the income effect*:

$$(W_i a/\overline{W}^*) = T_i/\overline{T} = W_i^*/\overline{C}_i^* \qquad \text{(A-7)}$$

(using relationship (A-6)). The respondent represented in Figure A-1 has a purely altruistic WTP represented on the horizontal axis as W^a (derivation of which we discuss further below). The altruistic WTP (W^a) exceeds the WTP for personal benefits (W^*) because it ignores the lesser exposure of that particular respondent, and is lower than population average $\overline{W}^*$ only to the extent justified by the respondent's lower income (i.e., his lower than average tax liability). (We might also be tempted to allow the altruistic respondent to take into account considerations such as the fact that he has a larger family to support, but we do not complicate the analysis to that extent here. To some extent, the respondent's original tax liability T (relative to his income) may already reflect such considerations, through deductions for dependents and similar tax mechanisms.)

In Figure A-1, the effect of setting taxes according to the purely altruistic response Wa (rather than according to W^*, the WTP for personal benefits alone) would be to raise society's joint distribution of W^* (WTP for personal benefits) and aT (increased tax liability) so that the point of means lies on the 45° line (at least according to the perceptions of respondent i concerning the tastes and taxes of others). To see this, note from relationship (A-7) that the altruistic tax increase for respondent i is by fraction ($\overline{W}^*/\overline{T}$):

$$Wa = (\overline{W}^*/\overline{T})T_i \qquad \text{(A-8)}$$

The same proportionate tax increase for all taxpayers implies an average tax increase equal to

$$\underset{i}{E}[(\overline{W}^*/\overline{T})T_i] = \overline{W}^* \quad . \qquad \text{(A-9)}$$

(In Figure A-1, the equal-probability contours of the implied joint distribution of W^* and aT are represented as concentric circles centered on the 45° line.)

Figure A-2 shows a geometric construction of purely altruistic response W^a within Figure A-1, given the WTP for personal benefits (W^*) and the population means ($\overline{W}^*,\overline{C}^*$) (leaving implicit respondent index i on W^a, W^*, and $\overline{C}^*$). A ray from the origin through point of means ($\overline{W}^*,\overline{C}^*$) intersects a horizontal line at height W^*, which determines a distance W^a along the horizontal axis. It is clear from the similarity of the right triangles formed (see the angles marked in the figure) that

$$(W^a/\overline{W}^*) = (W^*/\overline{C}^*) \qquad \text{(A-10)}$$

which is precisely definition (A-7) for altruistic response W^a. A similar construction is appropriate even when W^*, $\overline{W}^*$ and $\overline{C}^*$ are ordered differently, a possibility which we now consider.

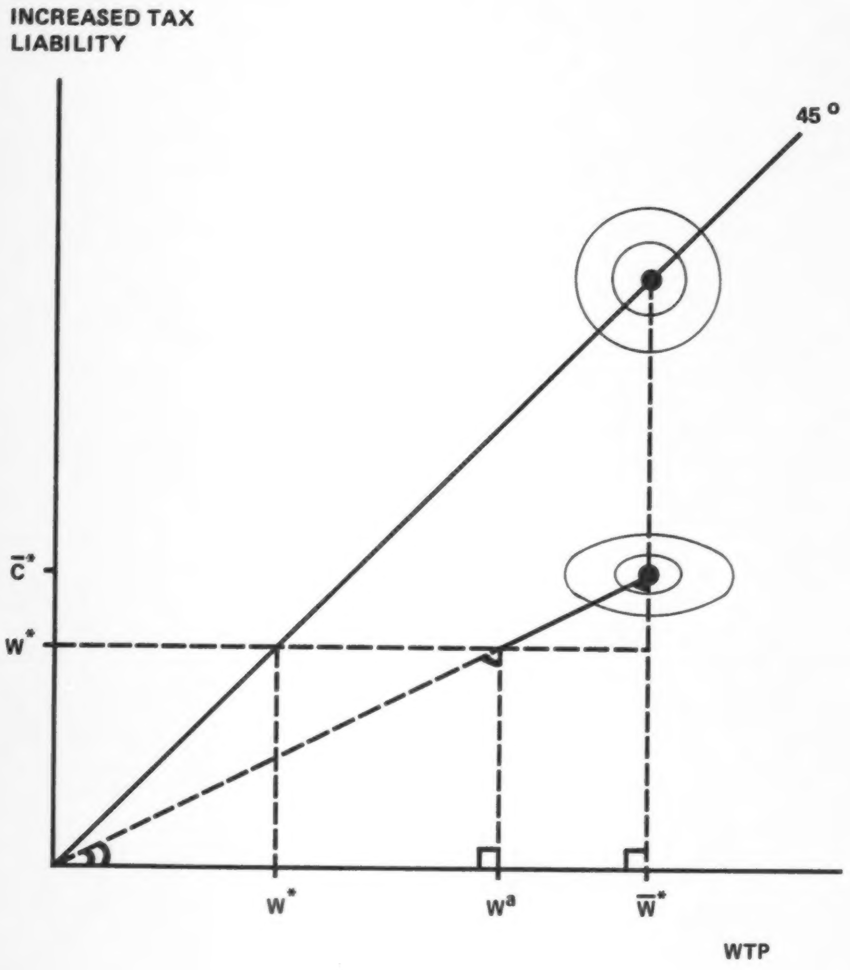
For the case depicted in Figures A-1 and A-2, purely altruistic WTP W^a exceeds WTP for personal benefits W^*, which might seem to be the normal state of affairs. However, $W^* < W^a$ is simply a reflection of the fact that exposure effect $(\overline{C}^*/\overline{W}^*) < 1$, which is indicated in the figures by the fact that the point of means ($\overline{W}^*,\overline{C}^*$) lies below the 45° line. It is perhaps equally likely (in a sense to be made more precise below) that the exposure effect will exceed one, implying purely altruistic W^a is less than WTP for personal benefits W^*. In fact, we will assume in this analysis that the altruistic respondent is just as concerned about others paying more for government health and safety programs than the corresponding personal benefits are worth to them, as he is about underrepresentation of others' WTP for personal benefits.

The first panel of Figure A-3 presents a case like that in Figures A-1 and A-2, for a respondent with $W^* < \overline{C}^* < \overline{W}^*$. Inequality $\overline{C}^* < \overline{W}^*$ implies the exposure effect is less than one, so $W^* < W^a$. Inequality $W^* < \overline{C}^*$ implies the income effect is also less than one, which reinforces the exposure effect to make individualistic W^* even further below population mean $\overline{W}^*$.

The second panel of Figure A-3 presents the case of a respondent for whom the exposure effect and the income effect are both greater than one. Because of the exposure effect, altruistic W^a is less than individualistic W^*. The purely altruistic response recognizes that the majority of other members of society value the government programs less than does the respondent for his own personal benefit (measuring relative to original tax liability). Both the high exposure and high income of this respondent operate to make individualistic W^* greater than the population mean WTP for personal benefits ($\overline{W}^*$).

Figure A-2

GEOMETRIC CONSTRUCTION OF THE PURELY ALTRUISTIC RESPONSE (W^a) FOR A PARTICULAR RESPONDENT

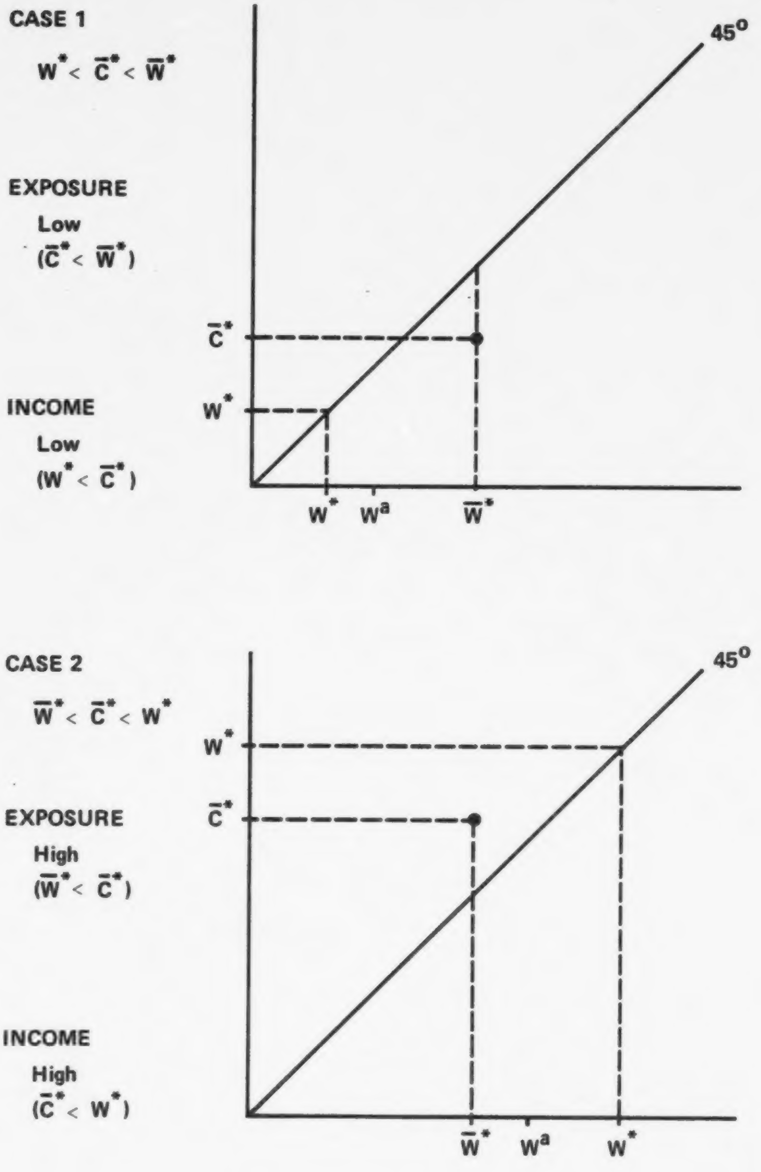

INCREASED TAX LIABILITY
45 °
$\bar{C}^*$
W^*
W^*
W^a
$\bar{W}^*$
WTP

NOTE: See Figure A-1 for an explanation of the symbols.

SOURCE: Charles River Associates, 1983.

Figure A-3

EXPOSURE EFFECTS, INCOME EFFECTS, AND THE IMPLIED RELATIONSHIPS AMONG THE RESPONDENT'S WTP FOR PERSONAL BENEFITS (W^*), HIS PURELY ALTRUISTIC WTP (W^a), AND THE POPULATION AVERAGE WTP FOR PERSONAL BENEFITS ($\overline{W}^*$)



NOTE: The horizontal axis measures Willingness to Pay (WTP): W^* is WTP for personal benefits of a particular respondent; $\overline{W}^*$ is the population average W^*; and W^a is the purely altruistic response for the respondent under consideration.

The vertical axis measures the implied additional tax liability: The respondent under consideration pays increased taxes equal to his WTP for personal benefits W^*, while the tax liability fraction appropriate for that respondent implies average increased tax liability for the entire population equal to $\overline{C}^*$.

For simplicity, we omit the respondent index i on these variables.

SOURCE: Charles River Associates, 1983.

Figure A-3 (continued)

EXPOSURE EFFECTS, INCOME EFFECTS, AND THE IMPLIED RELATIONSHIPS AMONG THE RESPONDENT'S WTP FOR PERSONAL BENEFITS (W^*), HIS PURELY ALTRUISTIC WTP (W^a), AND THE POPULATION AVERAGE WTP FOR PERSONAL BENEFITS ($\overline{W}^*$)

CASE 3

$\overline{C}^* < W^* < \overline{W}^*$

EXPOSURE

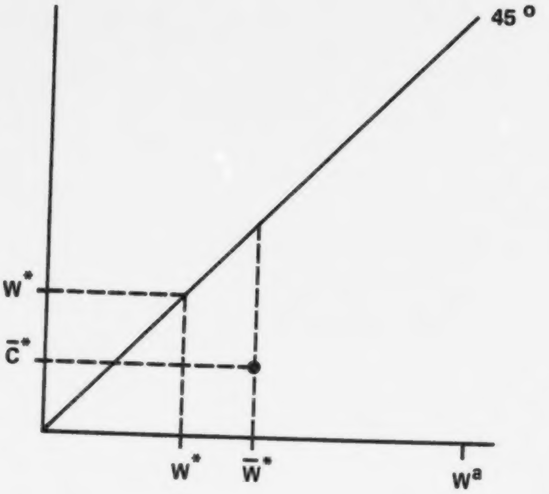
Very Low

($\overline{C}^* << \overline{W}^*$)

INCOME

High

($\overline{C}^* < W^*$)



CASE 4

$\overline{C}^* < \overline{W}^* < W^*$

EXPOSURE

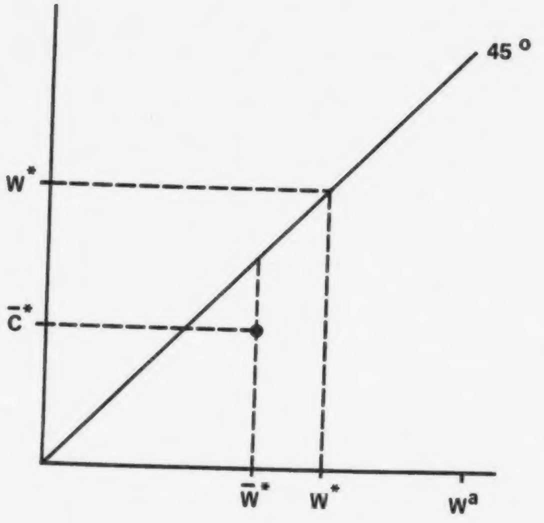
Low

($\overline{C}^* < \overline{W}^*$)

INCOME

Very High

($\overline{C}^* << W^*$)



NOTE: The horizontal axis measures Willingness to Pay (WTP): W^* is WTP for personal benefits of a particular respondent; $\overline{W}^*$ is the population average W^*; and W^a is the purely altruistic response for the respondent under consideration.

The vertical axis measures the implied additional tax liability: The respondent under consideration pays increased taxes equal to his WTP for personal benefits W^*, while the tax liability fraction appropriate for that respondent implies average increased tax liability for the entire population equal to $\overline{C}^*$.

For simplicity, we omit the respondent index i on these variables.

SOURCE: Charles River Associates, 1983.

Figure A-3 (continued)

EXPOSURE EFFECTS, INCOME EFFECTS, AND THE IMPLIED RELATIONSHIPS AMONG THE RESPONDENT'S WTP FOR PERSONAL BENEFITS (W^*), HIS PURELY ALTRUISTIC WTP (W^a), AND THE POPULATION AVERAGE WTP FOR PERSONAL BENEFITS ($\overline{W}^*$)

CASE 5

$W^* < \overline{W}^* < \overline{C}^*$

EXPOSURE

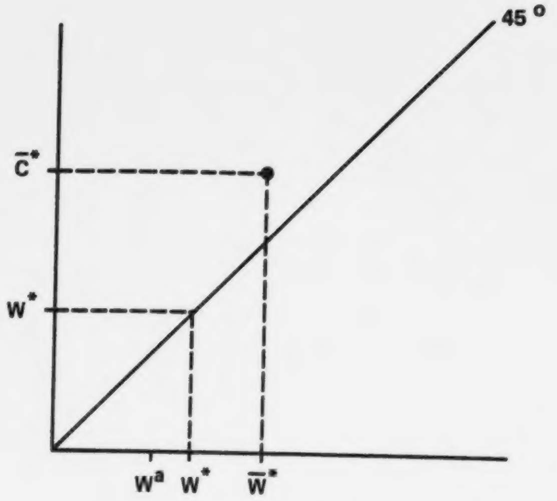
High

($\overline{W}^* < \overline{C}^*$)

INCOME

Very Low

($W^* << \overline{C}^*$)



CASE 6

$\overline{W}^* < W^* < \overline{C}^*$

EXPOSURE

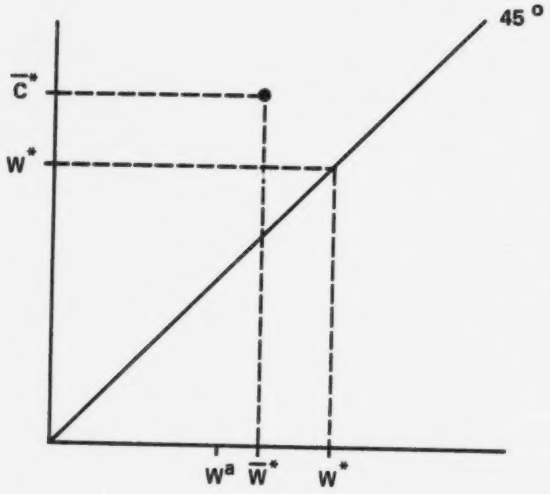
Very High

($\overline{W}^* << \overline{C}^*$)

INCOME

Low

($W^* < \overline{C}^*$)



NOTE: The horizontal axis measures Willingness to Pay (WTP): W^* is WTP for personal benefits of a particular respondent; $\overline{W}^*$ is the population average W^*; and W^a is the purely altruistic response for the respondent under consideration.

The vertical axis measures the implied additional tax liability: The respondent under consideration pays increased taxes equal to his WTP for personal benefits W^*, while the tax liability fraction appropriate for that respondent implies average increased tax liability for the entire population equal to $\overline{C}^*$.

For simplicity, we omit the respondent index i on these variables.

SOURCE: Charles River Associates, 1983.

There are six possible orderings of W^*, $\overline{W}$, and $\overline{C}^*$. These orderings indicate whether exposure and income for the respondent are high or low, and, where the two effects operate in opposite directions, which effect predominates in determining whether WTP for personal benefits W^* is less or greater than perceived population mean $\overline{W}^*$. The last four panels of Figure A-3 complete the description of all possible cases, mainly to emphasize the important point that altruism (as we have defined it) can just as easily lead to statement of a lower WTP as to statement of a higher WTP.

Note in the various panels of Figure A-3 that $\overline{W}^*$ (the population mean WTP for personal benefits), has the same value. This construction reflects the assumption (which we maintain below) that all respondents have an accurate understanding of the tastes and taxes of others -- at least in terms of their average WTP for personal benefits ($\overline{W}^*$) and their average original tax liability ($\overline{T}$). (It would be possible to introduce an error term -- say $\overline{W}_i{}^*$ = (true $\overline{W}^*$) + (error) -- but this generalization would add little to the analysis here.)

COMPARING AVERAGE WTP FOR A GOVERNMENT PROGRAM AND AVERAGE WTP FOR PERSONAL BENEFITS ALONE

Individuals differ in the extent of their altruism, just as they differ in the extent of their exposure to a hazard and the size of their income (taxes). We recognize this consideration by specifying that the individual's WTP for a government program is determined as a weighted average of his WTP for personal benefits W^* and his purely altruistic W^a:

$$W = (1-b)W^* + bW^a \qquad \text{(A-11)}$$

where weight b is a random variable across the population, distributed between zero and one. For a purely altruistic respondent, $b = 1$. (We ignore the intriguing possibility of misanthropic respondents for whom $b < 0$ might be appropriate.)

We are mainly interested in whether the population average WTP for the government program, which we label $\overline{W}$, tends to differ from the population average WTP for personal benefits alone ($\overline{W}^*$). For purposes of discussion below, we treat $\overline{W}^*$ as the appropriate social criterion for government health and safety programs, though we later reconsider that position.

The average W (WTP for the government program) for the whole population is

$$\overline{W} = E(W) = E[(1-b)W^* + bW^a] \qquad \text{(A-12)}$$

(where again we use bars to indicate means of individual random variables over the whole population). Remembering that $W^* = aT$ and $W^a = (T/\overline{T})\overline{W^*}$ (relationships (A-1) and (A-7) respectively, dropping the respondent index i)

$$\overline{W} = \overline{W^*} - E(baT) + (1/\overline{T})E(bT)E(aT) \quad . \qquad \text{(A-13)}$$

If altruism weight b, tax liability T, and tax liability proportion a are all distributed independently, then clearly the last two terms in equation (A-13) cancel to leave

$$\overline{W} = \overline{W^*} \quad . \qquad \text{(A-14)}$$

That is, the average WTP for the government program then exactly equals the average WTP for personal benefits.

A weaker but still sufficient condition for $\overline{W} = \overline{W^*}$ is that tax liability fraction a be uncorrelated with T and bT across the population:

$$\text{cov}(a,T) = 0 = \text{cov}(a,bT) \qquad \text{(A-15)}$$

which will hold if (but not only if) a is distributed independently of b and T. An alternative sufficient condition for $\overline{W} = \overline{W^*}$ is that altruism parameter b be uncorrelated with T and aT across the population:

$$\text{cov}(b,T) = 0 = \text{cov}(b,aT) \qquad \text{(A-16)}$$

which will hold if (but not only if) b is distributed independently of a and T.

Either the independence of a (reflecting exposure) or the independence of b (the altruism weight) is sufficient by itself to imply $\overline{W} = \overline{W^*}$. However, the independence of tax liability T is not sufficient to obtain this result, though it does lead to a simpler case that is somewhat easier to understand intuitively. General condition (A-13) reduces to

$$\overline{W} = \overline{W^*} - \overline{T}\,[E(ba) - \overline{b}\,\overline{a}\,] \quad . \qquad \text{(A-17)}$$

Or, in relative terms,

$$(\overline{W}/\overline{W}^*) = 1 - (1/\,\overline{a}\,)\mathrm{cov}(b,a)$$
$$= 1 - (\sigma_a/\,\overline{a}\,)\sigma_b \mathrm{cor}(b,a) \qquad \text{(A-18)}$$

where σ_a and σ_b are the standard deviations of a and b respectively, and cor(b,a) is their correlation coefficient (constrained to the range [-1,+1]).

(The ratio $(\sigma_a/\,\overline{a}\,)$ is sometimes called the "coefficient of variation" of random variable a.) We consider below the likely size of the relative bias term $(\sigma_a/\,\overline{a}\,)\sigma_b \mathrm{cor}(b,a)$, after working through several numerical examples, the first and last of which assume T is distributed independently.

NUMERICAL EXAMPLES

The meaning and relevance of the analytical framework presented above are clearer in the context of numerical examples. Consider a population consisting of 99 percent "middle-income" persons originally paying taxes T = \$10,000, and 1 percent "high-income" persons originally paying taxes T = \$1,000,000. The high-income group thus accounts for slightly more than half of average tax revenues:

$$\overline{T} = 0.99(\$10{,}000) + 0.01(\$1{,}000{,}000) = \$19{,}900 \qquad \text{(A-19)}$$

We further suppose that some individuals receive no personal benefit at all from the government program, implying a = 0, while all others have a WTP for personal benefits equal to 1 percent of their tax liability (a = 0.01). Also, we suppose that respondents are either entirely altruistic (b = 1, implying $W = W^a$) or entirely individualistic (b = 0, implying $W = W^*$). In other words, random variables a and b are assumed to have one-trial binomial distributions with probabilities yet to be specified, while tax liability T has a one-trial binomial distribution with probability 0.01. Two possible values for each of the three random variables (a, b and T) imply eight possible types of respondents.

We consider four sample cases. Case I is the simplest, assuming random variables T, a and b are distributed independently (and hence are uncorrelated), with probability 0.5 for both exposure (a = 0.01) and pure altruism (b = 1). The top half of Table A-1 displays the respondents' WTPs for personal benefits alone, $W^* = aT$, which determine non-altruistic responses where b = 0. Altruistic responses (b = 1) depend on the population average WTP for personal benefits, $\overline{W}^* = E(aT)$. For Case I

Table A-1

NUMERICAL EXAMPLE: WILLINGNESS TO PAY FOR THE GOVERNMENT PROGRAM (W_i) FOR THE EIGHT TYPES OF RESPONDENTS IN SAMPLE CASES I, II, AND IV.

		T = \$10,000	T = \$1,000,000
b=0 ($W=W^*$)	a=0	\$0	\$0
	a=0.01	\$100	\$10,000
b=1 ($W=W^a$)	a=0	\$50	\$5,000
	a=0.01	\$50	\$5,000

Table A-2

NUMERICAL EXAMPLE: WILLINGNESS TO PAY FOR THE GOVERNMENT PROGRAM (W_i) FOR THE FOUR TYPES OF RESPONDENTS IN SAMPLE CASE III.

		T = \$10,000	T = \$1,000,000
b=0 ($W=W^*$)	a=0	n.a.[1]	\$0
	a=0.01	\$100	n.a.[1]
b=1 ($W=W^a$)	a=0	n.a.[1]	\$4,975
	a=0.01	\$49.75	n.a.[1]

---

[1] Abbreviation "n.a." means that particular combination of respondent characteristics is *not applicable* to Case III.

SOURCE (for both tables): Charles River Associates, 1983.

$$\overline{W}^* = (0.99/2)(\$0 + \$100) + (0.01/2)(\$0 + \$10{,}000) = \$99.50 \quad . \qquad \text{(A-20)}$$

Therefrom, the lower half of Table A-1 can be derived, according to equation (A-7) for purely altruistic WTP, $W^a = (T/\overline{T})\overline{W}^*$. (As discussed above, we assume for simplicity that all respondents know the tastes and tax liabilities of other respondents, at least on average.) The average WTP for the government programs over all eight types of respondents in Case I is thus

$$\begin{aligned}\overline{W} = {} & (0.99/4)(\$0 + \$100 + \$50 + \$50) \\ & + (0.01/4)(\$0 + \$10{,}000 + \$5{,}000 + \$5{,}000) = \$99.50 = \overline{W}^* \quad . \qquad \text{(A-21)}\end{aligned}$$

This equality of average WTP for personal benefits alone ($\overline{W}^*$) and average WTP for the government program ($\overline{W}$) in Case I results from the independence of T, a, and b, as stated above for result (A-14).

The other three sample cases involve relaxing the assumption of mutual independence among T, a, and b, by assuming perfect correlation between pairs of these random variables (with independence of the third implying the other two cross-correlations remain zero). In particular, the other sample cases assume:

II. The rich are altruistic (b = 1) while people of moderate income are not, implying cor(b,T) = 1.

III. People of moderate income are exposed (a = 0.01) while the rich are not, implying cor(a,T) = -1.

IV. The exposed (a = 0.01) are non-altruistic (b = 0) while the non-exposed (a = 0) are altruistic (b = 1), implying cor(a,b) = -1.

For each of the sample cases II, III and IV, four of the eight possible types of respondents distinguished in Table A-1 are assumed not to exist. In terms of the organization of Table A-1, the types of respondents which are assumed to exist are indicated by "x" rather than "." in the following diagrams:

$$\begin{array}{cccc} \text{I.} & \text{II.} & \text{III.} & \text{IV.} \\[6pt] \begin{array}{|cc|}\hline x & x \\ x & x \\ \hline x & x \\ x & x \\ \hline\end{array} & \begin{array}{|cc|}\hline x & \cdot \\ x & \cdot \\ \hline \cdot & x \\ \cdot & x \\ \hline\end{array} & \begin{array}{|cc|}\hline \cdot & x \\ x & \cdot \\ \hline \cdot & x \\ x & \cdot \\ \hline\end{array} & \begin{array}{|cc|}\hline \cdot & \cdot \\ x & x \\ \hline x & x \\ \cdot & \cdot \\ \hline\end{array} \end{array} \qquad \text{(A-22)}$$

For Cases II, III and IV we continue with the assumption that the probabilities of exposure ($a = 0.01$) and pure altruism ($b = 1$) are 0.5, except that for Case III the probability of exposure ($a = 0.01$) is 0.99 (as required for compatibility with the maintained assumption that 99 percent of the population have moderate income with $T = \$10,000$).

For Cases II and IV, calculation (A-20) of $\overline{W}^* = E(aW^*) = \$99.50$ remains appropriate, so the values of W (WTP for the government program) in Table A-1 are applicable to Cases II and IV as well as Case I. However, for Case III the average WTP for personal benefits is slightly lower:

$$\overline{W}^* = (0.99)(\$100) + (0.01)(\$0) = \$99.00 \qquad \text{(A-23)}$$

Thus, the purely altruistic WTPs ($W^a = (T/\overline{T})\overline{W}^*$) are slightly lower. Table A-2 presents the revised WTP for the government program (W) for the four types of respondent occurring in Case III. (In terms of text diagrams (A-22), the difference between Case III and the other sample cases is that superimposing the bottom "square" of the diagram upon the top square does not put an "x" in all four corners of the composite square formed, reflecting the correlation between T and a assumed in Case III.)

For each of the three sample cases in which T, a, and b are not distributed mutually independently, the population average WTP for the government program is as follows:

Case II:

$$\overline{W} = (0.99/2)(\$0 + \$100) + (0.01/2)(\$5,000 + \$5,000) = \$99.50 = \overline{W}^* \qquad \text{(A-24)}$$

Case III:

$$\overline{W} = (0.99/2)(\$100 + \$49.75) + (0.01/2)(\$0 + \$4,975) = \$99.00 = \overline{W}^* \qquad \text{(A-25)}$$

Case IV:

$$\begin{aligned}\overline{W} &= (0.99/2)(\$100 + \$50) + (0.01/2)(\$10,000 + \$5,000) \\ &= \$149.25 > \$99.50 = \overline{W}^* \qquad \text{(A-26)}\end{aligned}$$

Case II illustrates sufficient condition (A-15) for $\overline{W} = \overline{W}^*$, since tax liability fraction a is distributed independently of b and T (which are perfectly correlated). Case III illustrates sufficient condition (A-16) for $\overline{W} = \overline{W}^*$, since altruism parameter b is distributed independently of a and T (which are perfectly correlated).

NUMERICAL EXAMPLE IV, AND FURTHER GENERAL ANALYSIS FOR INCOME INDEPENDENTLY DISTRIBUTED

Case IV illustrates a situation where altruism is perfectly negatively correlated with exposure, leading to an average WTP for the government program substantially *greater* than the average WTP for personal benefits ($\overline{W} > \overline{W}^*$, despite the fact that T is distributed independently). This bias resulting in Case IV makes sense intuitively: When exposed respondents state their WTP for the government program, they are *not* altruistic and do *not* take into account the "extra" payments potentially made by the non-exposed; on the other hand, the non-exposed respondents *are* altruistic and *do* take into account the benefits received by the exposed. Based on consideration of simplified cases such as the above numerical examples, we hypothesize that correlation among exposure and altruism is likely to be the most important reason that the average WTP for a government program (as measured by questions such as those in Part III of our questionnaire) would differ from the average WTP for personal benefits.

In Case IV, policy decisions based upon $\overline{W}$ will tend to penalize the altruistic and less exposed members of society. However, it is notable that even under the extreme assumptions of Case IV, the extent of the discrepancy between $\overline{W}$ and $\overline{W}^*$ is not extremely large ($\overline{W} = 1.5\overline{W}^*$ in fact). It seems likely that in more realistic cases, the extent of the discrepancy would be considerably less than 50 percent, even allowing for the fact that income (T) would presumably not be completely uncorrelated with exposure (a) and altruism (b).

Further, more general consideration of the case where original tax liability T is distributed independently sheds additional light on the likely size of the discrepancy between $\overline{W}$ and $\overline{W}^*$. Where T is independent, equation (A-18) shows that $(\overline{W}/\overline{W}^*) = 1 - (\sigma_a/\ \overline{a}\ )\sigma_b \mathrm{cor}(b,a)$. For Case IV, $(\sigma_a/\ \overline{a}\ ) = 1$, $\sigma_b = 0.5$, and $\mathrm{cor}(b,a) = -1$, implying $(\overline{W}/\overline{W}^*) = 1.5$, as already noted.

However, coefficient of variation $(\sigma_a/\ \overline{a}\ )$ can in principle be very much larger than one. For example, if a has a one-trial binomial distribution with probability π_a of a = (positive number) and probability $(1-\pi_a)$ of a = 0, then $(\sigma_a/\ \overline{a}\ ) = (1/\pi_a - 1)^{0.5}$, which becomes indefinitely large as $\pi_a \to 0$.

The above result for the case where a has the one-trial binomial distribution (and T is distributed independently) has the following meaning in more specific terms. Consider a range of situations in which $\overline{W}^*$ (the population average WTP for personal benefits) is the same, but the proportion of the population who are exposed (i.e., those for whom a = positive number) differs. Given σ_b and cor(b,a), the largest relative bias will then occur ($\overline{W}/\overline{W}^*$ will differ most from one) where very few people are willing to pay a very large proportionate tax increase ($\pi_a \to 0$). To take an extreme numerical example, if only one person in a million is exposed, then $(\sigma_a/\ \overline{a}\ ) = (1/10^{-6}\ -1)^{0.5} \cong 3{,}162$. It might appear that there is a serious danger that $\overline{W}/\overline{W}^*$) could be very large, or even very negative. However, the potential biases are not nearly so great, because ($\sigma_a/\ \overline{a}$) cannot be selected entirely independently of σ_b and cor(b,a).

Apparently, the greatest relative biases in $\overline{W}$ as an estimator of $\overline{W}^*$ will occur when cor(b,a) = +1 or -1. (We do not offer a general proof.) But in that case b and a are related linearly. To simplify the following discussion, we make the additional assumption that both a and b have minimum values of zero.

Consider first the case in which cor(b,a) = +1, implying $\overline{W} < \overline{W}^*$. Since a and b are assumed to have the same minimum value of zero and are linearly related in a positive fashion, they have the same coefficient of variation: $\sigma_a/\ \overline{a} = \sigma_b/\ \overline{b}$. Thus, equation (A-13) reduces to

$$(\overline{W}/\overline{W}^*) = 1 - \sigma_b^2/\ \overline{b} \quad . \qquad \text{(A-27)}$$

Altruism weight b is assumed restricted to the unit interval [0,1]. For a given average level of altruism $\overline{b}$, ratio $\sigma_b^2/\ \overline{b}$ will achieve its maximum value if b (and hence a) has a one-trial binomial distribution with probability π_b of b = 1 (b = 0 otherwise). In that case, $\sigma_b^2 = \pi_b(1-\pi_b)$ and $\overline{b} = \pi_b$, implying the following inequality:

$$(\overline{W}/\overline{W}^*) = 1 - \sigma_b^2/\overline{b} > \overline{b} \qquad \text{(A-28)}$$

Thus, there is in fact no danger of $\overline{W}$ having the wrong sign (which was clear earlier from the fact that W^* and W^a are both postive, as indicated for example by the geometric construction in Figure A-2). However, $\overline{W}$ could in principle be only a small fraction of $\overline{W}^*$.

However, we suspect that negative correlation between exposure and altruism is a much more likely source of bias in $\overline{W}$ as an estimator of $\overline{W}^*$, in this case a positive bias. Consider the extreme case in which cor(b,a) = -1, implying $\overline{W} > \overline{W}^*$. It is not true in this case that b and a have equal coefficients of variation, because the maximum value of b (say b_m) now corresponds to the minimum value of a (zero), and the minimum value of b (zero) now corresponds to the maximum value of a (say a_m). Using this new notation, $\sigma_b = (b_m/a_m)\sigma_a$ and $b_m = \overline{b}a_m/(a_m - \overline{a})$. Substituting into equation (A-18),

$$(\overline{W}/\overline{W}^*) = 1 + \{\sigma_a{}^2/[\ \overline{a}(a_m-\overline{a})]\}\ \overline{b} \quad . \qquad \text{(A-29)}$$

For a given average tax liability proportion $\overline{a}$ (reflecting "exposure"), factor $\sigma_a{}^2/[\ \overline{a}(a_m-\overline{a})]$ will achieve its maximum value of one if a has a one-trial binomial distribution, implying

$$(\overline{W}/\overline{W}^*) \leq 1 + \overline{b} \quad . \qquad \text{(A-30)}$$

(Note that the equality above held for numerical example Case IV considered earlier.) Since $\overline{b}$ is between zero and one, the theoretical maximum value for $(\overline{W}/\overline{W}^*)$ is 2. But in fact $\overline{W}$ is likely to be much closer to $\overline{W}^*$ than that in any realistic situation.

ADJUSTMENTS FOR INCOME DISTRIBUTION AND OTHER POSSIBLE GENERALIZATIONS

In the above analysis, the acceptance of average WTP for personal benefits $(\overline{W}^*)$ as the appropriate social criterion, and the definition of altruism for the individual respondent (leading to the definition of W^a), are plausible. However, there are alternative assumptions, or more general assumptions, that might well be preferred. Perhaps the most likely such assumption is that income distribution (as reflected in original tax liability T) should matter less than we have supposed by simply adding up various individuals' WTP for personal benefits (W^*).

Where government health and safety programs are at issue, many people undoubtedly feel that the effect of income levels on WTP for personal benefits should be discounted to some degree. It would be possible to generalize in this direction the model we have presented, by transforming individuals' WTP for personal benefits (W^*) and original tax liability (T) prior to calculating their purely altruistic responses and/or the appropriate social benefits criterion. For purposes of calculating purely altruistic responses, the parameter of this transformation could be distributed across the population as a random variable. (One reason we drew the equal-probability contours into Figures A-1 and A-2 was the thought that information beyond population means $\overline{W}^*$ and $\overline{C}^*$ would be required for such useful model generalizations.)

We do not develop such a generalization here. However, we do consider the very simple limiting case where only the ratio of W^* (WTP for personal benefits) to T (original tax liability) is assumed to matter, regardless of income level; say

$$a_i^* = W_i^*/T_i \qquad \text{(A-31)}$$

in terms of our earlier notation. This proportion can be assumed to reflect "exposure" alone, so that a purely altruistic response would simply be population average $\overline{a}^*$, which also represents the appropriate social criterion.

The average response to a question on maximum WTP for a government program, measured solely as a proportion of original tax liability T, would be

$$\overline{a} = E[(1-b)a^* + b\overline{a}^*] \qquad \text{(A-32)}$$

where b is again the altruism weight. Since

$$\overline{a} = \overline{a}^* - [E(ba^*) - \overline{b}\,\overline{a}^*] \qquad \text{(A-33)}$$

it is clear that zero correlation between random variables a^* and b is both a necessary and sufficient condition for the average questionnaire response to equal the appropriate social criterion:

$$\overline{a} = \overline{a^*} \quad \text{iff} \quad cor(a^*,b) = 0 \qquad \text{(A-34)}$$

Even in the more general model developed earlier, we ended up expressing greatest concern about possible correlation between tax liability fraction a (reflecting exposure) and altruism weight b. This condition was a source of bias in $\overline{W}$ as an estimator of $\overline{W^*}$, even where income is distributed independently. Now we see that it is the only potential source of bias in a model where WTP for personal benefits is normalized as a ratio to tax liability, before calculating altruistic responses or the appropriate overall social criterion. (Results (A-33) and (A-17) are very similar.)

A further possible model generalization would be to allow a particular respondent's extent of altruism toward others to differ across the population, so that for example extra weight would be given to family and friends, or perhaps just to people from the respondent's own part of the country. Such considerations could be important in explaining individual responses. However, it seems unlikely they would be a major source of bias in the comparison of population averages $\overline{W}$ and $\overline{W^*}$, so we do not pursue such possibilities here.

CONCLUSIONS

Equation (A-11) defines an individual respondent's (expressed) WTP for a particular government program as a weighted average of his (unexpressed) WTP for personal benefits alone and his (unexpressed) purely altruistic WTP : $W = (1-b)W^* + bW^a$. Up to this point we have focused on the variation in weight b across individuals, and its implications for recovering information about W^* from W, at least in terms of population averages. However, it is also important to note that there is no reason that weight b should be stable for a given individual across different government programs. In fact, people appear to have systematic preferences about the worthiness of others' preferences, which are likely to affect strongly the extent of altruism in their WTPs for various government programs. Taking an example upon which our study has focused, people appear to give more weight to others' WTPs for personal benefits (in comparison with additional taxes paid) where the government program prevents deaths from air pollution, as opposed to deaths of persons who choose to smoke or drive recklessly. Our results indicate that an important underlying reason is that risks from air pollution are considered to be much less easy to avoid (i.e., "less voluntary").

In terms of the analytical framework developed in this appendix, we can only guess at the main effect of respondents' considering a particular hazard "voluntary" and "easy to avoid," where WTP for personal benefits W^* and altruistic WTP W^a are unobserved. The most likely effect probably would be to lower the altruism weight b of less exposed individuals. It is also conceivable that more exposed individuals would have a higher altruism weight b, perhaps because they feel somewhat "guilty" about choosing to smoke or to drive over the speed limit. Either or both of these effects would tend to raise the correlation between altruism and exposure, cor(b,a). If, as we suspect, cor(b,a) is typically negative, these effects would make cor(b,a) less negative and would reduce average WTP for the government program $\overline{W}$ toward average WTP for personal benefits $\overline{W}^*$ -- other things equal.

However, in fact there are "other things" which vary among major government programs sufficiently strongly to swamp the effect just described. Thinking just in terms of the simplified case where income (tax liability) is distributed independently of altruism and exposure, consider equation (A-18) for the relative bias:

$$(\overline{W}/\overline{W}^*) = 1 - (\sigma_a/\ \overline{a}\ )\sigma_b \mathrm{cor}(b,a) \quad .$$

As already discussed, the coefficient of variation for exposure $(\sigma_a/\ \overline{a}\ )$ will tend to be smaller if large numbers of people account for the average $\overline{a}$, (rather than small numbers of highly threatened people). Furthermore, in the limit, if most people feel exposed to a similar extent, a will be more stable and cor(b,a) will tend toward zero. This situation may be representative of major environmental hazards, as opposed to hazards which severely threaten much smaller segments of the population. Because of considerations such as these, it is not really safe to generalize that environmental programs will on average elicit a $\overline{W}$ that is unusually large relative to $\overline{W}^*$, simply because it is likely to elicit more altruism among the less exposed. (As a general tendency in the population, we suspect that higher average altruism $\overline{b}$ will typically be associated with higher σ_b; that is not a mathematical necessity, but it is very plausible in the likely situation where $\overline{b}$ is considerably below 0.5, even for very worthy government programs.)

Heretofore, we have accepted average WTP for personal benefits $\overline{W}^*$ as the appropriate social criterion, and have treated altruism (as embodied in altruistic WTP W^a and weight b) as a source of bias in estimating $\overline{W}^*$ from questions asking about WTP for government programs (W). Correspondingly, we have interpreted the situation where altruism and exposure are negatively correlated ($cor(b,a) < 0$, tending to cause $\overline{W} > \overline{W}^*$) as one in which more-exposed-and-less-altruistic people are in effect "taking advantage" of less-exposed-and-more-altruistic people. However, the appropriateness of this position is open to question. Note particularly that the only way $\overline{W}^*$ can be reduced for a hazard that is considered "voluntary" ("easy to avoid") is if exposed individuals reduce their WTP for personal benefits, perhaps because they "feel guilty" about choosing to expose themselves to the hazard (the same reason we gave above for exposed respondents' giving more altruistic weight to the costs and benefits of the government program for other people). Relying simply on voluntarily exposed people to feel guilty about their choice of activities hardly seems an adequate conceptualization of the importance many people attach to this type of consideration. (As discussed in the text, various investigators have distinguished many different characteristics of risks -- beyond "voluntariness" or "ease of avoidance" -- that may affect the value people attach to reducing those risks for others. However, we feel that voluntariness is the most important such distinction for analysis of EPA policies, and we couch our discussion in this appendix simply in terms of that particular risk characteristic.)

The alternative position is that individuals' utility functions are in truth interdependent, and people receive extra utility from seeing others in society protected from involuntary hazards (as opposed to those that they could easily avoid). From this perspective, in the limit the average WTP for a government program, $\overline{W}$, would itself be the appropriate social criterion. There is of course no objectively right or wrong answer to the question of whether $\overline{W}$ or $\overline{W}^*$ is the better social criterion. Perhaps the preferred criterion lies somewhere in between for many people in the United States. (On the other hand, the question of how individuals incorporate altruism into their stated WTP for a government program is an empirical one. Future empirical studies may show that the hypothesis underlying (A-32) is more accurate than hypothesis (A-11), or that something in between or quite different is more accurate.)

In principle, the most straightforward way to resolve many of the issues now under consideration would be to obtain direct information on each respondent's WTP for personal benefits alone (W^*) *and* on his preferences among government programs affecting only others, both in terms of benefits received and taxes paid (in effect, W^a). However, expanding the scope of a questionnaire to address these issues would substantially increase the burden on respondents, would apparently necessitate questions that are more difficult to comprehend, and might well fail ultimately because of the basic inadequacies of questionnaires for measuring people's true tastes.

The major technique we have used for making our questionnaire more comprehensible is to concentrate (in Part II) on measuring trade-offs among government programs in terms of numbers of fatalities prevented that make respondents judge the programs equally worthwhile. This technique makes it unnecessary for the respondent to think in terms of reductions in very small risk probabilities, or to state his willingness to pay (WTP) in dollar terms, taking into account all the other goods and services competing for a place within his budget constraint. It is difficult to see how a similarly simple technique could be adapted to measuring an individual's WTP for personal health and safety benefits alone.

Holding constant considerations such as age at death and associated pain and suffering, most individuals presumably want to minimize their overall probability of dying, regardless of whether their lives are spared while they are driving automobiles, riding airplanes, breathing the ambient air, or doing any of the other activities they have decided upon -- which is largely just another way of saying that society's total WTP for personal benefits is a social criterion that inadequately incorporates preferences for protecting people against "involuntary" hazards. (To some extent activities may be chosen simultaneously with extent of safety measures, but, at the margin determined by current conditions and over the relevant range determined by realistic additional health and safety measures, that complication does not seem to be very important. Most people would not start smoking simply because the risk of death had been cut in half, and most would continue to ride in automobiles even if the risk of death doubled.)

It might be useful to ask respondents what percentage reductions in the probability of death from one hazard would make them indifferent toward a specified percentage reduction in the probability of death from a second hazard. Such questions might reveal the respondent's exposure to various hazards in a useful fashion. However, the concepts involved appear less easily comprehended than the construction we actually use for Part II of this study's questionnaire (involving specification of trade-offs among numbers of fatalities prevented, as described above). (As discussed in the text, we presume responses in Part II reflect ratios of WTPs for government programs).

Asking about respondents' preferences among government programs that affect only other people (in terms of both benefits received and taxes paid) is a conceivable approach to measuring W^a directly. However, the hypothetical context is likely to be regarded as so artificial that it is unclear that the responses could be interpreted literally. Responses could be elicited in the same simplified fashion as Part II of the current questionnaire, but might be very little different if respondents ignored the unrealistic hypothesis that they alone are unaffected by the government program.

For questions asking about WTP for personal benefits alone (as discussed above, an approach to measuring W^*) similar ambiguities in the interpretation of questionnaire responses might well arise. A respondent who habitually drives his automobile at high speeds while drunk might not be honest even with himself about what he really would be willing to pay for a safety program benefiting people who expose themselves to that type of hazard. His response to a hypothetical question about WTP for personal benefits might thus be biased toward the altruistic response. This result may be unfortunate from the viewpoint of scientific analysis of voters' true preferences, but on the other hand it might lead ultimately to more appealing social decisions about government programs benefiting only drunken drivers. (This example is more clear-cut if we treat as a separate policy problem the protection of innocent victims of drunken drivers.)

In summary, questions asking about WTP for government health and safety programs appear to be the most useful first step toward distinguishing the desirability of the programs on the basis of the diverse nature of the hazards involved, particularly the extent to which they are "voluntary" (easy to avoid). Such questions appear to be the best way to conceptualize and measure people's preference that members of society be protected more extensively from involuntary hazards, and to estimate the lesser social value of protection from hazards that are easier to avoid. Moreover, in most cases the WTP for a government program is probably not greatly different on average from the WTP for personal benefits alone. On a more practical level, hypothetical questions about government programs that increase everyone's taxes and benefit all exposed individuals are "realistic," simulating voting on public goods in a democratic society. Questionnaires are uncertain instruments for measuring people's true tastes, and such greater realism can only improve their accuracy, particularly where such sensitive and controversial issues are being investigated. Future questionnaires may allow empirical decomposition of WTP for government programs into WTP for personal benefits and an altruistic component, as we have done at an abstract level in this appendix. However, it very probably would have been self-defeating to attempt to measure all these concepts with one group of respondents answering one questionnaire.

APPENDIX B

BASIC UTILITY FUNCTIONS AND RISK-CHARACTERISTICS UTILITY FUNCTIONS FOR INDIVIDUAL RESPONDENTS

The computer listings reproduced in this appendix describe all estimated coefficients of the Basic Utility Functions and Risk-Characteristics Utility Functions, for all 15 respondents. These results are summarized in Tables 2, 3 and 5 in the text.

As described in the text, the Basic Utility Functions and Risk-Characteristics Utility Functions were originally estimated by Ordinary Least Squares in log-linear form. In order that results be interpretable as "relative WTPs," the coefficients from those log-linear regressions are always presented in the form "exp(-coefficient)." These results are identified below with column headings indicating the regressor variables to which they correspond.

Column headings used for both the Basic Utility Functions and Risk-Characteristics Utility Functions are as follows:

RESP	Respondents number (1 to 15)
SD2-SD19	Section dummies (to adjust for different response scales among the 19 sections of Part II -- not a substantive result)
AD1-AD3	Age group dummies (for the 20s, 60s and 80s respectively)

LIFEEX	Lifetime-halved dummy (for those cases in which survivors' health is impaired)
INTERCEPT	Intercept term (not a substantive result)

Column headings used only for the Basic Utility Functions are as follows:

GD2-GD61	Government program dummies (for each risk type)

Column headings used only for the Risk-Characteristics Utility Functions are as follows:

RA	Rating for difficulty of avoiding hazard (Section A of Part I -- subjective scale 1 to 7)
RB	Rating for personal exposure (Section B of Part II -- subjective scale 1 to 7)
OCCHAZ	Occupational hazard dummy
FIRPOL	Fireman-or-policeman dummy

```
BASIC UTILITY FUNCTIONS:

RESP   GD2     GD3     GD4     GD5     GD6     GD7     GD8     GD9     GD10    GD11

  1  1.12017 0.62739 0.56008 1.03733 1.05416 1.01412 1.00489 0.67300 0.50475 1.05935
  2  0.38252 0.26338 0.11476 0.94348 0.45337 1.06238 0.74521 0.62916 1.25833 1.07419
  3  1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
  4  0.98160 0.00964 0.00001 0.87810 0.94581 1.18629 0.99997 0.21783 0.21783 1.88016
  5  1.00048 1.00096 1.00048 1.00335 1.00144 1.00450 1.01493 1.00970 1.00970 0.99857
  6  0.10188 0.05189 0.05094 1.13898 0.35245 1.33626 1.00065 0.38545 1.15634 1.41424
  7  1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
  8  0.65100 0.47678 0.32550 0.84667 0.62077 0.93140 0.83727 0.88309 0.88309 1.25670
  9  0.18427 0.03396 0.00002 1.44277 0.12514 1.80291 0.85225 0.87651 0.03506 1.11204
 10  0.80122 0.24073 0.12018 0.90539 0.43398 0.96137 0.98088 0.97108 0.97108 0.96883
 11  0.79612 0.71303 0.23883 0.86579 0.85148 1.01047 1.39367 1.18670 1.18670 0.98757
 12  1.41223 0.99719 0.14122 0.93357 2.81652 1.47646 1.00912 0.43156 0.34524 0.22316
 13  1.19484 0.71382 0.39828 0.86918 0.85290 0.91009 0.81866 0.86317 0.86317 0.98592
 14  0.86867 0.25153 0.86867 1.03681 0.21850 1.09894 0.96796 0.51569 0.34379 1.30776
 15  1.16386 0.13546 0.01164 0.72317 0.15765 0.85740 0.62420 0.36578 0.07316 1.18058
RESP   GD12    GD13    GD14    GD15    GD16    GD17    GD18    GD19    GD20    GD21

  1  1.05935 0.55569 1.05935 1.05935 0.55569 0.64165 1.05935 0.64470 0.61597 1.10875
  2  1.07419 0.39574 1.07419 1.07419 1.25143 1.25143 1.07419 0.87707 0.79253 1.18879
  3  1.00000 0.76314 1.00000 1.00000 0.93466 0.93466 1.00000 1.00000 1.00000 1.00000
  4  1.88016 0.18802 1.88016 1.88016 0.18802 0.18802 1.88016 0.18802 0.18802 1.88016
  5  0.99857 0.79256 0.99857 0.99857 0.56043 0.56043 0.99857 0.99857 0.99857 0.24964
  6  1.41424 0.27330 1.41424 1.41424 0.70566 0.61112 1.41424 1.00002 1.18923 1.18923
  7  1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
  8  1.25670 0.38059 1.25670 0.62835 0.38059 0.38059 0.62835 0.56201 0.53152 0.44293
  9  1.11204 0.01870 1.11204 1.11204 0.02645 1.00000 1.11204 0.90798 0.82045 2.46135
 10  0.96883 0.26658 0.96883 0.96883 0.92347 0.92347 0.96883 0.96883 0.96883 0.96883
 11  0.98757 0.47478 0.98757 0.98757 0.82234 0.82234 0.98757 0.98757 0.98757 0.98757
 12  0.22316 0.14807 0.44632 0.14877 0.06045 0.06622 0.11158 0.66949 0.66949 0.33474
 13  0.98592 0.14471 0.98592 0.98592 0.14471 0.45763 0.98592 0.49296 0.49296 0.98592
 14  0.87184 0.38836 0.65388 0.87184 0.77672 0.54922 0.65388 1.30776 0.87184 0.43592
 15  1.18058 1.05178 1.18058 1.18058 1.05178 0.74372 1.18058 1.18058 1.18058 0.39353
```

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BASIC UTILITY FUNCTIONS (CONTINUED):

RESP  GD22    GD23    GD24    GD25    GD26    GD27    GD28    GD29    GD30    GD31

  1  0.73258 0.36629 0.29303 0.75352 0.50235 0.38753 0.50235 0.92789 0.97939 0.92789
  2  0.63945 0.42630 0.42630 0.42732 0.64098 0.64250 0.12820 0.94561 0.93223 0.63041
  3  1.00000 0.66667 0.66667 1.00000 1.00000 1.00000 0.66667 1.00000 1.00000 1.00000
  4  0.40764 0.40764 0.40764 0.55343 0.05534 0.07514 0.05534 0.65100 1.03965 0.65100
  5  1.22437 1.22437 1.22437 1.62180 1.62180 0.42965 1.62180 1.13333 1.04907 1.13333
  6  0.20074 0.40147 0.02007 0.03875 0.03875 0.18702 0.03875 1.24113 1.53474 0.12411
  7  1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
  8  0.57332 0.57332 0.38221 0.83515 0.55677 0.54070 0.55677 1.06793 0.79570 1.06793
  9  1.74435 0.03489 0.01744 0.34160 0.34160 0.13379 0.03416 1.54626 1.37066 0.07731
 10  1.29557 0.25911 0.25911 1.93740 0.19374 0.28972 0.48435 1.15857 1.03605 0.11586
 11  1.05195 1.05195 1.05195 1.03875 1.03875 1.02571 1.03875 1.13477 1.22410 1.13477
 12  0.66875 0.06688 0.06688 0.41663 0.41663 0.25956 0.55551 1.07226 0.57308 0.10723
 13  0.62049 0.31024 0.31024 0.68070 0.68070 0.14935 0.22690 0.71192 0.81683 0.71192
 14  0.80360 0.26787 0.26787 0.83628 0.55752 0.58019 0.55752 1.06764 0.94563 0.71176
 15  0.78340 0.26113 0.15668 0.48841 0.48841 0.24360 0.48841 0.83383 0.44375 0.41692
RESP  GD32    GD33    GD34    GD35    GD36    GD37    GD38    GD39    GD40    GD41

  1  0.32801 0.47833 0.23917 0.31889 0.19133 1.00621 1.00031 1.00031 1.00031 1.01104
  2  0.64556 0.64403 0.32201 0.64403 0.32201 0.92561 0.88266 0.88266 0.88266 0.94394
  3  1.00000 1.00000 0.66667 1.00000 0.66667 1.00000 1.00000 1.00000 1.00000 1.00000
  4  0.13849 0.10201 1.02007 0.10201 0.10201 1.31383 0.91809 0.91809 0.91809 0.52014
  5  0.75386 0.56912 0.28456 0.56912 0.28456 1.00932 1.02019 1.02019 1.02019 1.00797
  6  0.17424 0.01805 0.02256 0.18052 0.02006 0.24136 0.57728 0.57728 0.34637 1.21345
  7  1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000
  8  0.40795 0.70012 0.52509 1.05018 0.42007 0.45789 0.79384 0.39692 0.52923 0.57859
  9  0.51311 0.26201 0.13101 0.26201 0.05240 0.91251 0.82867 0.82867 0.82867 0.88475
 10  0.64787 0.43324 0.43324 0.43324 0.43324 0.97974 0.99078 0.99078 0.99078 0.96783
 11  1.00013 0.50642 0.33761 1.01284 0.20257 0.89900 1.63674 1.63674 1.63674 0.77988
 12  0.80596 0.64684 0.12937 0.06468 0.12937 0.38484 0.23597 0.23597 0.58991 0.29021
 13  0.17974 0.16384 0.08192 0.16384 0.08192 0.61868 0.77645 0.77645 0.77645 0.87853
 14  0.62833 0.40252 0.30189 0.40252 0.30189 0.88996 0.90845 0.90845 0.90845 0.83610
 15  0.18936 0.15187 0.10125 0.30374 0.10125 0.56070 0.53260 0.53260 0.53260 0.51808
```

BASIC UTILITY FUNCTIONS (CONTINUED):

RESP	GD42	GD43	GD44	GD45	GD46	GD47	GD48	GD49	GD50	GD51
1	1.00031	0.66687	0.40012	1.05935	0.88279	0.38865	0.388655	1.00808	0.50202	0.83669
2	0.88266	0.88266	0.88266	1.07419	1.07419	0.29158	0.291581	0.98033	0.33004	0.99012
3	1.00000	1.00000	0.66667	1.00000	1.00000	0.87358	0.873580	1.00000	0.66667	1.00000
4	0.91809	0.91809	0.09181	1.88016	1.88016	0.01880	0.018802	0.32819	0.05729	0.05729
5	1.02019	1.02019	1.02019	0.99857	0.49928	0.41937	0.419372	0.99904	0.49976	0.99952
6	0.21648	0.17318	0.03464	1.41424	0.28285	0.21126	0.211259	0.30469	0.00552	0.27599
7	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	0.100000	1.00000	1.00000	2.00000
8	0.52923	0.39692	0.26461	2.51339	1.67559	0.23053	0.230529	0.42813	0.30845	0.61690
9	0.82867	0.82867	0.16573	2.22408	0.02224	0.00031	0.000315	0.09313	0.02158	0.00863
10	0.99078	0.99078	0.19816	0.96883	0.32294	0.29341	0.088024	0.97911	0.49475	0.98950
11	0.81837	1.63674	0.40918	0.98757	0.98757	0.22825	0.228248	0.99170	0.24896	0.99584
12	1.17983	0.16855	0.11798	0.29755	0.44632	0.24562	0.491243	0.20056	0.20028	1.00141
13	0.77645	0.77645	0.38823	0.98592	0.49296	0.10621	0.106205	0.99059	0.49764	0.99529
14	0.90845	0.90845	0.45423	1.30776	0.87184	0.46132	0.345989	0.54102	0.40287	0.67145
15	0.53260	0.53260	0.53260	1.18058	0.59029	0.93703	0.937028	0.42623	0.30776	0.92328

RESP	GD52	GD53	GD54	GD55	GD56	GD57	GD58	GD59	GD60	GD61
1	0.66936	0.73040	1.00000	0.66667	1.02076	0.51038	1.02076	0.51038	1.02076	1.02076
2	0.49506	1.42160	1.00000	0.50000	0.98172	0.49086	0.98172	0.32724	0.98172	0.98172
3	1.00000	0.65485	1.00000	0.66667	1.00000	0.66667	1.00000	1.00000	1.00000	1.00000
4	0.05729	1.02283	1.00000	0.10000	0.81524	0.08152	0.81524	0.08152	0.81524	0.81524
5	0.99952	1.15681	0.33333	0.20000	1.00527	0.50264	1.00527	0.50264	1.00527	1.00527
6	0.11040	0.81320	1.00000	0.10000	1.22690	0.12269	1.22690	0.24538	0.61345	1.22690
7	1.00000	1.25153	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
8	0.61690	0.40597	0.66667	0.66667	0.76985	0.25662	0.76985	0.38493	0.76985	0.76985
9	0.00432	1.03982	0.20000	0.01000	1.66344	0.16634	1.66344	0.03327	1.66344	1.66344
10	0.19790	1.89594	1.00000	0.10000	0.94444	0.18889	0.94444	0.18889	0.94444	0.94444
11	0.49792	1.64785	1.00000	0.33333	0.88035	0.88035	0.88035	0.88035	0.88035	0.88035
12	0.10014	1.31819	0.66667	0.50000	0.92833	0.18567	0.92833	0.46417	0.46417	0.92833
13	0.99529	1.56597	1.00000	1.00000	0.88576	0.88576	0.88576	0.88576	0.88576	0.88576
14	0.67145	1.59080	1.00000	0.66667	0.98396	0.65597	0.98396	0.65597	0.75689	0.98396
15	0.46164	0.56053	1.00000	1.00000	0.72979	0.52128	0.72979	0.60816	0.66345	0.72979

```
BASIC UTILITY FUNCTIONS (CONTINUED):

RESP   SD2     SD3     SD4     SD5     SD6     SD7     SD8     SD9     SD10    SD11    SD12    SD13

  1  1.10963 1.33460 1.06261 1.04060 1.05741 1.01029 1.10672 1.52907 1.48657 1.20722 1.77216 2.34181
  2  0.91197 1.10426 1.26560 1.33327 1.06830 0.96532 1.18227 1.79459 1.79033 1.21357 0.87717 1.78185
  3  1.00000 1.16769 1.00000 0.94775 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 0.95912 1.00000
  4  0.90126 1.97632 1.03784 0.21404 0.52208 0.52208 0.52208 0.24080 1.77366 1.50782 0.91799 0.96229
  5  0.99086 1.13662 0.99904 1.09551 1.00191 1.00191 1.00191 0.81714 0.61689 0.88277 0.99450 1.75794
  6  0.88102 1.21519 0.96350 0.76942 0.72036 0.85666 0.60575 5.07512 5.25794 0.82084 0.71017 5.64358
  7  1.00000 0.50761 1.00000 0.51461 1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 0.44068 1.00000
  8  1.10578 1.08932 1.04870 0.77350 0.77704 0.73488 0.82162 0.85162 0.58462 0.91439 1.67726 0.92984
  9  1.05115 0.96152 2.94507 0.93778 1.65704 0.74865 0.91691 1.05638 0.53943 1.19171 0.73001 7.03280
 10  1.23763 1.44064 1.38467 1.37397 1.24050 1.24050 1.24050 0.92764 0.62033 1.03734 0.91428 2.77402
 11  1.00630 1.26949 1.40247 1.35268 1.20920 1.20920 1.20920 1.13520 1.14963 1.05235 1.22159 1.17904
 12  0.81810 0.53783 0.50141 3.71936 3.16413 2.10942 0.70314 2.11173 1.69480 1.31705 1.18293 2.18328
 13  1.38425 1.24456 1.40091 1.16348 1.21190 1.21190 1.21190 1.92565 1.75531 1.67833 2.73917 7.29257
 14  0.84225 1.00437 0.79513 0.61467 0.66425 0.66425 0.66425 1.08098 1.03874 0.81364 0.86711 1.43873
 15  1.59091 0.76687 1.47649 0.90633 0.98583 0.98583 0.98583 1.48564 1.19148 1.39579 0.52359 3.83177

RESP  SD14    SD15       SD16    SD17    SD18    SD19     AD1      AD2       AD3      LIFEEX  INTERCEPT

  1  1.11982 1.05741   1.9214 1.18421 1.12017 1.09738 0.94212 0.887582 0.593496 0.91274 0.089273
  2  1.30012 1.06830   0.7871 1.07823 1.14756 1.16893 1.07493 0.917095 0.591555 0.70343 0.087141
  3  1.00000 1.00000   0.7631 1.02007 1.00000 1.00000 0.98032 0.733402 0.748125 1.01805 0.100000
  4  1.06918 0.52208   0.5221 1.93995 0.98160 1.20407 0.88324 0.362096 0.190288 0.97768 0.101874
  5  0.98068 1.00191   1.5904 1.07334 1.00048 0.99523 0.93256 0.869670 0.740174 0.43222 0.099952
  6  0.58826 0.72036   0.9645 1.77408 1.01876 0.83036 1.04033 0.608563 0.208067 0.40991 0.098158
  7  1.00000 1.00000   1.0000 0.04865 1.00000 1.00000 2.05568 0.639904 0.477082 0.79902 0.100000
  8  1.23010 0.38852   1.4120 1.08001 0.97650 1.26843 0.97711 0.728604 0.453534 0.98530 0.102406
  9  1.11183 0.82852  58.5850 2.02208 1.84269 1.10776 2.11150 0.304954 0.033518 0.19234 0.054268
 10  1.21301 1.24050   1.3653 1.51925 1.20183 1.27253 0.79946 0.558341 0.108504 0.52744 0.083207
 11  0.72961 1.20920   1.7440 1.27479 1.19417 1.35648 0.94067 0.884865 0.940673 0.60685 0.083740
 12  1.19697 3.16413   2.8748 0.88963 1.41223 1.52125 1.58519 0.375367 0.199722 0.75862 0.070810
 13  1.53885 1.21190   5.6251 1.25046 1.19484 1.34894 0.96005 0.921690 0.960047 0.63858 0.083693
 14  0.95622 0.66425   1.2554 1.20511 0.86867 0.88284 0.89462 0.800338 0.390760 0.62861 0.115118
 15  2.18525 0.98583   0.6210 0.86376 1.16386 1.59477 1.45938 0.392313 0.231663 0.89202 0.085921
```

RISK-CHARACTERISTICS UTILITY FUNCTIONS

RESP	RA	RB	OCCHAZ	FIRPOL	SD2	SD3	SD4	SD5	SD6	SD7	SD8	SD9	SD10	SD11
1	1.04672	1.05115	1.39704	1.14600	0.8214	1.6485	1.1508	1.1495	0.9995	0.8572	0.8950	0.7966	0.8880	1.0384
2	1.09002	1.18615	1.50681	1.12819	1.7106	1.6653	1.7664	1.8888	2.0239	1.6372	1.9180	2.1725	1.6967	1.7147
3	1.02147	1.02055	1.03597	1.05323	0.9218	1.0915	0.9844	0.9433	0.9512	1.0014	0.9728	0.7856	0.9384	1.0340
4	1.07215	1.52977	2.12530	2.37711	25.6692	60.3718	19.4354	10.0984	16.0653	12.4854	9.7638	8.2452	19.7712	44.2822
5	1.05672	1.06225	1.05911	1.06560	0.8442	0.8483	0.9182	0.7586	0.7620	0.6600	0.8366	1.1501	0.7087	0.8481
6	1.31776	1.26328	1.45892	1.57400	1.9235	1.7592	1.8391	2.2394	3.4043	4.3657	1.4702	8.6996	3.2610	1.8180
7	0.96281	1.03891	1.05533	1.11384	1.0672	0.4892	1.0191	0.4795	1.0273	0.9998	1.0705	1.0129	1.0075	1.0152
8	1.11524	1.06630	1.09075	1.03442	1.3545	1.3657	1.1934	1.5462	0.8854	0.8022	0.7730	0.8666	0.7734	1.2763
9	1.13924	1.73333	2.93970	1.68794	10.6112	10.2543	30.0304	12.1689	14.0895	25.1186	22.0808	14.2782	17.7295	70.0191
10	0.93438	1.35135	1.79876	1.47204	1.6205	1.7045	1.4922	1.0678	1.2581	1.0280	1.3633	0.6208	0.5918	1.0418
11	0.90321	1.14054	1.13956	1.39714	1.6447	1.1608	1.7644	1.4646	1.6004	1.3972	1.5972	1.6532	2.1354	1.7647
12	0.97328	1.11749	1.39945	1.31522	0.5784	0.4358	0.7506	0.8891	0.5511	0.7590	0.4104	0.5508	1.1246	1.1240
13	1.02751	1.04784	1.08384	0.91608	1.3055	1.4416	1.4314	1.1038	0.8019	0.9985	0.8881	0.9657	0.8584	1.3484
14	1.04542	1.15897	1.51682	1.06741	0.6295	1.0018	0.5693	0.7092	0.5507	0.7349	0.6888	0.6888	1.0747	1.0047
15	1.01938	1.16441	1.37550	1.11895	2.2816	2.6628	2.5028	2.9488	4.5043	3.3682	2.3558	2.6733	2.6794	3.7609

RESP	SD12	SD13	SD14	SD15	SD16	SD17	SD18	SD19	AD1	AD2	AD3	LIFEEX	INTERCEPT
1	1.2352	0.745	0.8384	0.8772	1.2702	1.1718	0.9928	1.0718	0.90578	0.873089	0.57061	0.82086	0.0586576
2	1.4625	1.847	2.4990	1.5808	1.5611	1.6848	2.0479	1.9043	1.14672	0.942255	0.63106	0.83747	0.0153540
3	1.0072	0.865	0.9365	0.9568	0.7159	0.9614	0.8151	0.9315	0.95483	0.725358	0.72867	0.94821	0.0882119
4	7.8173	8.042	26.2846	26.4566	3.3084	16.6078	14.9333	24.0342	0.95174	0.373597	0.20505	1.19594	0.0004405
5	0.8470	0.743	0.9607	0.7127	1.0082	0.8160	0.4703	0.7998	1.01928	0.902650	0.80900	0.54939	0.0677482
6	3.4447	2.685	1.1096	1.6424	2.7215	1.1104	2.3543	2.2295	1.27791	0.663283	0.25558	0.71394	0.0034072
7	1.0000	1.072	1.1087	1.0499	0.6124	0.0605	1.1215	1.0689	2.06376	0.682176	0.51594	0.88776	0.0962090
8	1.5844	0.865	1.2257	0.9379	1.0324	1.0733	1.1862	1.2522	0.95217	0.720760	0.44196	0.91891	0.0312818
9	21.9866	107.715	37.0176	5.3178	12.4726	3.2934	19.1971	32.3261	2.84162	0.345321	0.04511	0.42855	0.0001376
10	0.5112	2.225	1.4989	0.7546	1.0147	1.4583	0.9152	1.3340	0.89597	0.585624	0.12160	0.71730	0.0276379
11	1.1682	1.409	1.1646	1.6058	1.5372	1.1309	1.1820	1.7567	1.04599	0.925061	1.04599	0.80801	0.0561991
12	0.6117	0.560	0.5913	0.8438	0.7645	0.4203	1.1169	1.0831	1.56157	0.373015	0.19675	0.72850	0.0257002
13	1.6835	0.998	1.2427	1.0439	1.2284	1.3131	1.5053	1.3153	0.98878	0.933138	0.98878	0.69146	0.0573008
14	1.2785	0.828	0.8747	0.8259	1.0071	1.1081	0.8493	0.9806	0.91780	0.808955	0.40088	0.67353	0.0482516
15	2.5697	2.978	5.2278	2.9647	3.7706	2.1430	5.1744	3.8074	1.42971	0.388955	0.22695	0.84394	0.0104315

APPENDIX C

INVITATION TO PARTICIPATE IN THE EXPERIMENTAL SAMPLES

The following page reproduces the letter used to invite respondents to the experimental sample meetings. The reply postcard mentioned in the letter (which is not reproduced here) was an important mechanism. Without the repeat invitations which it facilitated, the response rate would have been below 10 percent rather than 14 percent.

CRA
CHARLES RIVER
ASSOCIATES
INCORPORATED

JOHN HANCOCK TOWER
200 CLARENDON STREET
BOSTON, MASSACHUSETTS 02116
(617) 266-0500

May 3, 1984

Dear ______________________:

You are invited, as a member of the Newton League of Women Voters, to help me develop a questionnaire to measure the preferences of U.S. voters among different government health and safety programs. Under a grant from the U.S. government, I am investigating the relative importance of reducing risks due to highway accidents, occupational dangers, contagious diseases, and many other types of hazards. This project was organized by my company, Charles River Associates, an economic research organization located in the John Hancock Tower in downtown Boston.

A meeting (with several other participants) will be held at my home in Newton Corner on Wednesday, May 23 at 7:30 P.M., to administer a preliminary version of the questionnaire. You will be encouraged to identify any lack of clarity in the questionnaire, and generally to suggest improvements. Under normal circumstances, the questionnaire is designed to be taken in a little more than an hour. However, discussion of how to improve the questionnaire may take additional time. As partial compensation for your time and trouble, you will receive a participant's fee of $25.

Please mail the enclosed postcard to indicate that you plan to participate. If you cannot attend this meeting, but might be able to attend a future meeting, please mark the second box on the postcard (and save this letter). A map of the Newton Corner area, showing the location of my home, is enclosed. If you have any questions, you may telephone me at 965-1610 (early evening is the best time).

Sincerely yours,

CHARLES RIVER ASSOCIATES

Steven D. Beggs

Steven D. Beggs
Senior Research Associate

SDB/th
Enclosures

TIME: Wednesday, May 23 at 7:30 P.M.
PLACE: 93 Arlington Street, Newton Corner. (Near Bigelow Junior High School, a Tudor-style home, four houses east of the intersection with Waverly Street, on the north side of the street.)

APPENDIX D

QUESTIONNAIRE ON RISK CHARACTERISTICS AND THE WORTH OF HEALTH AND SAFETY PROGRAMS

QUESTIONNAIRE ON
RISK CHARACTERISTICS AND THE WORTH OF HEALTH AND SAFETY PROGRAMS

The U.S. government has limited money to spend on programs that reduce risks to its people's health and safety. As a result, difficult decisions must be made about which health and safety programs should be given money and which cannot. This questionnaire asks about your opinions and values in a way that can help the government decide which health and safety programs should be supported.

This questionnaire contains four parts. Part I asks (1) whether you think it is easy or hard to avoid exposure to different kinds of hazards, and (2) whether you are exposed to those hazards more or less than the average person in the United States. Part II asks you to compare the worth of government programs that reduce the risk of death from various hazards (such as automobile accidents and cancer from air pollution). Part III asks how much new taxes you would be willing to pay for a new government health or safety program. Finally, Part IV asks for background information about you and your family.

Many of the questions we ask are very hard. However, making judgments about them is like voting on a referendum, or evaluating the platforms of competing political candidates. You never have all the information you would like to have. Yet some judgment and conclusion must be reached. This questionnaire should be approached in that same spirit. There are no "right" or "wrong" answers, so simply give us your best personal judgments and do not agonize over individual answers.

We appreciate very much your volunteering to answer this questionnaire. Of course, your answers will be held in strictest confidence and never attributed to you personally. The general pattern of results from this study will be described in a short report which you can request at the end of the questionnaire.

PART I: HOW EASY IS IT TO AVOID EXPOSURE TO VARIOUS HAZARDS, AND HOW MUCH ARE YOU PERSONALLY EXPOSED?

SECTION A

People can avoid most of their "exposure" to the risk of being killed in an automobile accident by not riding in automobiles. People can avoid exposure to the risks of smoking by not smoking. People can avoid most of their exposure to the risks from air pollution by moving away from cities to areas with little air pollution. People can avoid exposure to the risk of dying from a fall while mountain climbing by not climbing mountains. People can avoid being killed as a policeman by not taking a job as a policeman.

In this section we ask you to compare many different kinds of risks or hazards like these, according to how easy it is to avoid exposure to the hazard. In particular, we ask:

> "To what extent is it unreasonably costly, inconvenient or unpleasant for people to avoid exposing themselves to the risk of death from the following hazards?"

Risks that are easy to avoid are sometimes called "voluntary" risks.

We use a rating scale that goes from 1 to 7:

Easy and reasonable to avoid					Unreasonably costly, inconvenient or unpleasant (or impossible) to avoid	
1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

For each hazard, if you think that it is typically very easy to avoid the hazard, mark an "X" in the box below the number 1. If you think it is typically very costly, inconvenient or unpleasant to avoid the hazard -- or, if you think it is virtually impossible to avoid the hazard -- mark below the number 7. Use the middle numbers 2 through 6 for hazards that are neither very easy nor very hard to avoid.

We often describe separately different kinds of people that may die from a hazard. For example, we separate highway accidents that kill passengers of automobiles from highway accidents that kill drivers of automobiles. We also separate drivers who are illegally speeding or driving while drunk. Rate each of the hazards by considering the people who might die from them. For example, people can avoid death in accidents that kill drunken drivers by not driving while drunk. (To be specific, we ask in Question 4 below how "unreasonably costly, inconvenient or unpleasant" it is for people not to drive while legally drunk.)

Often, it is easier for people to avoid a hazard by an earlier decision rather than a later decision. For example, it is probably easier not to start smoking than it is to stop smoking. And it is probably easier not to take a job as a policeman than it is to leave the job. In these cases, please tell us how easy it is to avoid hazards by making early decisions.

Of course, it is easier for some people to avoid hazards than it is for others. Please try to answer for the situation that is most common or most typical these days.

Please answer from the viewpoint of an adult, not a child. (This questionnaire does not consider hazards to children.)

In order to simplify this questionnaire, we only look at hazards that are bad enough to cause death. We do not look at hazards that just cause injuries or damage property.

* * * * * FIRST RISK CHARACTERISTIC * * * * *

A. Ease of Avoiding Hazards
To what extent is it unreasonably costly, inconvenient or unpleasant for people to avoid exposing themselves to the risk of death from the following hazards?

		Easy and reasonable to avoid				Unreasonable costly, inconvenient, or unpleasant (or impossible) to avoid		
		1	2	3	4	5	6	7
1.	Highway accidents that kill drivers of automobiles who are obeying traffic laws -- other people not involved	☐	☐	☐	☐	☐	☐	☐
2.	Highway accidents that kill driver of automobiles who are exceeding the 55 mph speed limit by 15 mph (but are not legally drunk) -- other people not involved	☐	☐	☐	☐	☐	☐	☐
3.	Highway accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 30 mph (but are not legally drunk) -- other people not involved	☐	☐	☐	☐	☐	☐	☐
4.	Highway accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 15 mph and whose alcohol blood levels make them legally drunk -- other people not involved	☐	☐	☐	☐	☐	☐	☐
5.	Highway accidents that kill passengers in automobiles whose drivers are obeying traffic laws	☐	☐	☐	☐	☐	☐	☐
6.	Highway accidents that kill passengers in automobiles whose drivers are exceeding the 55 mph speed limit by 30 mph (but are not legally drunk) -- other cars not involved .	☐	☐	☐	☐	☐	☐	☐
7.	Airplane accidents that kill passengers of regularly scheduled airlines	☐	☐	☐	☐	☐	☐	☐
8.	Airplane accidents that kill pilots and crews of regularly scheduled airlines	☐	☐	☐	☐	☐	☐	☐
9.	Airplane accidents that kill people on the ground who have chosen to buy a less expensive house near an airport . .	☐	☐	☐	☐	☐	☐	☐
10.	Airplane accidents that kill people on the ground who are not near an airport or other area with high airplane traffic	☐	☐	☐	☐	☐	☐	☐
11.	Cancer from air pollution	☐	☐	☐	☐	☐	☐	☐
12.	Cancer from manmade radiation in the general environment	☐	☐	☐	☐	☐	☐	☐
13.	Cancer from smoking cigarettes	☐	☐	☐	☐	☐	☐	☐
14.	Cancer from unauthorized dumping of toxic waste in residential areas	☐	☐	☐	☐	☐	☐	☐
15.	Cancer from residual insecticides and herbicides in foods	☐	☐	☐	☐	☐	☐	☐
16.	Cancer from artificial sweeteners	☐	☐	☐	☐	☐	☐	☐
17.	Cancer from intrauterine devices (IUDs)	☐	☐	☐	☐	☐	☐	☐
18.	Cancer from chemical pollution of streams, lakes and rivers	☐	☐	☐	☐	☐	☐	☐
		1	2	3	4	5	6	7

A. **Ease of Avoiding Hazards**
To what extent is it unreasonably costly, inconvenient or unpleasant for people to avoid exposing themselves to the risk of death from the following hazards?

		Easy and reasonable to avoid				Unreasonable costly, inconvenient, or unpleasant (or impossible) to avoid		
		1	2	3	4	5	6	7
19.	Heart attacks	☐	☐	☐	☐	☐	☐	☐
20.	Strokes	☐	☐	☐	☐	☐	☐	☐
21.	Botulism poisoning in canned foods purchased at a grocery store	☐	☐	☐	☐	☐	☐	☐
22.	Fires from faulty electrical wiring in single-family houses	☐	☐	☐	☐	☐	☐	☐
23.	Fires in single-family houses from leaving hair dryers running near flammable material	☐	☐	☐	☐	☐	☐	☐
24.	Electrocutions from using hair dryers while bathing	☐	☐	☐	☐	☐	☐	☐
25.	Fires from faulty gas room heaters in single-family houses	☐	☐	☐	☐	☐	☐	☐
26.	Fires from faulty Christmas tree lights in single-family houses	☐	☐	☐	☐	☐	☐	☐
27.	Fires from lightning striking single-family houses	☐	☐	☐	☐	☐	☐	☐
28.	Fires in single-family houses from inhabitants falling asleep while smoking	☐	☐	☐	☐	☐	☐	☐
29.	Fires from faulty electrical wiring in apartment buildings	☐	☐	☐	☐	☐	☐	☐
30.	Fires from faulty electrical wiring in office buildings	☐	☐	☐	☐	☐	☐	☐
31.	Fires from faulty electrical wiring in night clubs	☐	☐	☐	☐	☐	☐	☐
32.	Tornadoes	☐	☐	☐	☐	☐	☐	☐
33.	Flash floods striking travelers with no warning	☐	☐	☐	☐	☐	☐	☐
34.	Flash floods striking people who chose to buy a less expensive house in a known flood plain	☐	☐	☐	☐	☐	☐	☐
35.	Lightning striking people	☐	☐	☐	☐	☐	☐	☐
36.	Extraordinarily high storm tides, striking people who have chosen to live at the beachfront	☐	☐	☐	☐	☐	☐	☐
37.	Policemen killed in the general line of duty	☐	☐	☐	☐	☐	☐	☐
38.	Coal mining accidents	☐	☐	☐	☐	☐	☐	☐
39.	Accidents killing farmers on tractors	☐	☐	☐	☐	☐	☐	☐
40.	Accidents killing firemen in the general line of duty	☐	☐	☐	☐	☐	☐	☐
		1	2	3	4	5	6	7

A. Ease of Avoiding Hazards
To what extent is it unreasonably costly, inconvenient or unpleasant for people to avoid exposing themselves to the risk of death from the following hazards?

		Easy and reasonable to avoid				Unreasonable costly, inconvenient, or unpleasant (or impossible) to avoid		
		1	2	3	4	5	6	7
41.	Highway accidents killing long-haul truck drivers who are obeying traffic laws	☐	☐	☐	☐	☐	☐	☐
42.	Accidents killing highway construction workers	☐	☐	☐	☐	☐	☐	☐
43.	Accidents during construction and repair work high above the ground (by ironworkers, steeplejacks, etc.)	☐	☐	☐	☐	☐	☐	☐
44.	Accidents to movie stunt men	☐	☐	☐	☐	☐	☐	☐
45.	Cancer from having worked in a job where there was no information of increased cancer risk	☐	☐	☐	☐	☐	☐	☐
46.	Cancer from having worked in a job where there was extensive information of increased cancer risk	☐	☐	☐	☐	☐	☐	☐
47.	Cirrhosis of liver from extreme alcohol consumption	☐	☐	☐	☐	☐	☐	☐
48.	Drug overdoses by drug addicts	☐	☐	☐	☐	☐	☐	☐
49.	Drownings while swimming in a supervised pool	☐	☐	☐	☐	☐	☐	☐
50.	Drownings while swimming alone in an abandoned quarry clearly marked as "dangerous" and "private property -- keep out"	☐	☐	☐	☐	☐	☐	☐
51.	Drownings while boating	☐	☐	☐	☐	☐	☐	☐
52.	Drownings while scuba diving	☐	☐	☐	☐	☐	☐	☐
53.	Fatal complications during surgical operations to slow the progression of diseases that are expected to cause death eventually	☐	☐	☐	☐	☐	☐	☐
54.	Fatal complications during surgical operations to alleviate severe pain	☐	☐	☐	☐	☐	☐	☐
55.	Fatal complications during major cosmetic surgery	☐	☐	☐	☐	☐	☐	☐
56.	Passengers on intercity buses killed in highway accidents	☐	☐	☐	☐	☐	☐	☐
57.	Passengers on small private planes, with non-professional pilots, killed in accidents	☐	☐	☐	☐	☐	☐	☐
58.	Passengers on railroads, killed in accidents	☐	☐	☐	☐	☐	☐	☐
59.	Motorcyclists killed in accidents	☐	☐	☐	☐	☐	☐	☐
60.	Bicyclists struck by automobiles and killed	☐	☐	☐	☐	☐	☐	☐
61.	Pedestrians struck by automobiles and killed	☐	☐	☐	☐	☐	☐	☐
		1	2	3	4	5	6	7

* * * * * END FOR THIS CHARACTERISTIC * * * * *

SECTION B

People who ride in automobiles more than the average person (especially on dangerous roads) probably will be "exposed" to the risk of death in an automobile accident more than the average person. People who smoke one pack of cigarettes each day will be exposed to the risks of smoking less than people who smoke three packs each day, but much more than people who do not smoke at all. People who live or work in large cities probably will be exposed to the risk of death from diseases caused by air pollution more than the average person in the U.S. People who live in the country, far from heavy traffic and big factories, probably will be exposed to the risk of death from air pollution much less than the average person in the U.S.

In this section we ask you to compare different hazards according to whether you personally are likely to be exposed to that risk more than the average person. In particular, we ask

> "In the forseeable future, are you likely to be exposed to the risk of death from the following hazards more than the average person? (If your risk-exposure probably will be about average for the U.S. population, mark "4".)"

Again we use a rating scale that goes from 1 to 7:

I will not be exposed				I will be exposed much more than average		
1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Some of the hazards will not apply to you at all, so you should mark below the number 1. For example, if you never drive 30 mph over the 55 mph speed limit, then you will not be exposed to death from highway accidents that kill drivers who speed by 30 mph (where other people are not involved in the accident). Similarly, if you do not become an airline pilot, or a policeman, or a movie stunt man, then you will not be exposed to death from accidents that occur on those kinds of jobs, and you should mark below the number 1. If you would not live in a house near an airport, or on a flood plain, or at the beachfront, then you will not be exposed to death from the hazards of living in those locations, and you should mark 1.

Remember, we are asking you to compare your exposure to the exposure of the average person in the U.S. We are not asking you whether you think the hazard is important. For example, you may doubt that manmade radiation in the general environment causes cancer very often. However, unless you take special care to avoid this hazard (whatever it is), you presumably will be exposed about as much as the average person. If so, you should answer 4 (not 1).

A final example: Say you do a lot of boating, but are more careful than the average person who goes boating. Because the majority of people in the U.S. do not go out in a boat very often, you should answer above 4. However, because you are more careful than the average person who goes out in a boat, you probably should answer 5 or 6, rather than 7.

* * * * * NEW RISK CHARACTERISTIC * * * * *

B. Personal Exposure to Hazards
In the forseeable future, are you likely to be exposed to the risk of death from the following hazards more than the average person? (If your risk-exposure probably will be about average for the U.S. population, mark "4".)

		I will not be exposed				I will be exposed much more than average		
		1	2	3	4	5	6	7
1.	Highway accidents that kill drivers of automobiles who are obeying traffic laws -- other people not involved	☐	☐	☐	☐	☐	☐	☐
2.	Highway accidents that kill driver of automobiles who are exceeding the 55 mph speed limit by 15 mph (but are not legally drunk) -- other people not involved	☐	☐	☐	☐	☐	☐	☐
3.	Highway accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 30 mph (but are not legally drunk) -- other people not involved	☐	☐	☐	☐	☐	☐	☐
4.	Highway accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 15 mph and whose alcohol blood levels make them legally drunk -- other people not involved	☐	☐	☐	☐	☐	☐	☐
5.	Highway accidents that kill passengers in automobiles whose drivers are obeying traffic laws	☐	☐	☐	☐	☐	☐	☐
6.	Highway accidents that kill passengers in automobiles whose drivers are exceeding the 55 mph speed limit by 30 mph (but are not legally drunk) -- other cars not involved	☐	☐	☐	☐	☐	☐	☐
7.	Airplane accidents that kill passengers of regularly scheduled airlines	☐	☐	☐	☐	☐	☐	☐
8.	Airplane accidents that kill pilots and crews of regularly scheduled airlines	☐	☐	☐	☐	☐	☐	☐
9.	Airplane accidents that kill people on the ground who have chosen to buy a less expensive house near an airport	☐	☐	☐	☐	☐	☐	☐
10.	Airplane accidents that kill people on the ground who are not near an airport or other area with high airplane traffic	☐	☐	☐	☐	☐	☐	☐
11.	Cancer from air pollution	☐	☐	☐	☐	☐	☐	☐
12.	Cancer from manmade radiation in the general environment	☐	☐	☐	☐	☐	☐	☐
13.	Cancer from smoking cigarettes	☐	☐	☐	☐	☐	☐	☐
14.	Cancer from unauthorized dumping of toxic waste in residential areas	☐	☐	☐	☐	☐	☐	☐
15.	Cancer from residual insecticides and herbicides in foods	☐	☐	☐	☐	☐	☐	☐
16.	Cancer from artificial sweeteners	☐	☐	☐	☐	☐	☐	☐
17.	Cancer from intrauterine devices (IUDs)	☐	☐	☐	☐	☐	☐	☐
18.	Cancer from chemical pollution of streams, lakes and rivers	☐	☐	☐	☐	☐	☐	☐
		1	2	3	4	5	6	7

B. **Personal Exposure to Hazards**

In the forseeable future, are you likely to be exposed to the risk of death from the following hazards more than the average person? (If your risk-exposure probably will be about average for the U.S. population, mark "4".)

		I will not be exposed				I will be exposed much more than average		
		1	2	3	4	5	6	7
19.	Heart attacks	☐	☐	☐	☐	☐	☐	☐
20.	Strokes	☐	☐	☐	☐	☐	☐	☐
21.	Botulism poisoning in canned foods purchased at a grocery store	☐	☐	☐	☐	☐	☐	☐
22.	Fires from faulty electrical wiring in single-family houses	☐	☐	☐	☐	☐	☐	☐
23.	Fires in single-family houses from leaving hair dryers running near flammable material	☐	☐	☐	☐	☐	☐	☐
24.	Electrocutions from using hair dryers while bathing	☐	☐	☐	☐	☐	☐	☐
25.	Fires from faulty gas room heaters in single-family houses	☐	☐	☐	☐	☐	☐	☐
26.	Fires from faulty Christmas tree lights in single-family houses	☐	☐	☐	☐	☐	☐	☐
27.	Fires from lightning striking single-family houses	☐	☐	☐	☐	☐	☐	☐
28.	Fires in single-family houses from inhabitants falling asleep while smoking	☐	☐	☐	☐	☐	☐	☐
29.	Fires from faulty electrical wiring in apartment buildings	☐	☐	☐	☐	☐	☐	☐
30.	Fires from faulty electrical wiring in office buildings	☐	☐	☐	☐	☐	☐	☐
31.	Fires from faulty electrical wiring in night clubs	☐	☐	☐	☐	☐	☐	☐
32.	Tornadoes	☐	☐	☐	☐	☐	☐	☐
33.	Flash floods striking travelers with no warning	☐	☐	☐	☐	☐	☐	☐
34.	Flash floods striking people who chose to buy a less expensive house in a known flood plain	☐	☐	☐	☐	☐	☐	☐
35.	Lightning striking people	☐	☐	☐	☐	☐	☐	☐
36.	Extraordinarily high storm tides, striking people who have chosen to live at the beachfront	☐	☐	☐	☐	☐	☐	☐
37.	Policemen killed in the general line of duty	☐	☐	☐	☐	☐	☐	☐
38.	Coal mining accidents	☐	☐	☐	☐	☐	☐	☐
39.	Accidents killing farmers on tractors	☐	☐	☐	☐	☐	☐	☐
40.	Accidents killing firemen in the general line of duty	☐	☐	☐	☐	☐	☐	☐
		1	2	3	4	5	6	7

B. Personal Exposure to Hazards

In the forseeable future, are you likely to be exposed to the risk of death from the following hazards more than the average person? (If your risk-exposure probably will be about average for the U.S. population, mark "4".)

		I will not be exposed				I will be exposed much more than average		
		1	2	3	4	5	6	7
41.	Highway accidents killing long-haul truck drivers who are obeying traffic laws	☐	☐	☐	☐	☐	☐	☐
42.	Accidents killing highway construction workers	☐	☐	☐	☐	☐	☐	☐
43.	Accidents during construction and repair work high above the ground (by ironworkers, steeplejacks, etc.)	☐	☐	☐	☐	☐	☐	☐
44.	Accidents to movie stunt men	☐	☐	☐	☐	☐	☐	☐
45.	Cancer from having worked in a job where there was no information of increased cancer risk	☐	☐	☐	☐	☐	☐	☐
46.	Cancer from having worked in a job where there was extensive information of increased cancer risk	☐	☐	☐	☐	☐	☐	☐
47.	Cirrhosis of liver from extreme alcohol consumption	☐	☐	☐	☐	☐	☐	☐
48.	Drug overdoses by drug addicts	☐	☐	☐	☐	☐	☐	☐
49.	Drownings while swimming in a supervised pool	☐	☐	☐	☐	☐	☐	☐
50.	Drownings while swimming alone in an abandoned quarry clearly marked as "dangerous" and "private property -- keep out"	☐	☐	☐	☐	☐	☐	☐
51.	Drownings while boating	☐	☐	☐	☐	☐	☐	☐
52.	Drownings while scuba diving	☐	☐	☐	☐	☐	☐	☐
53.	Fatal complications during surgical operations to slow the progression of diseases that are expected to cause death eventually	☐	☐	☐	☐	☐	☐	☐
54.	Fatal complications during surgical operations to alleviate severe pain	☐	☐	☐	☐	☐	☐	☐
55.	Fatal complications during major cosmetic surgery	☐	☐	☐	☐	☐	☐	☐
56.	Passengers on intercity buses killed in highway accidents	☐	☐	☐	☐	☐	☐	☐
57.	Passengers on small private planes, with non-professional pilots, killed in accidents	☐	☐	☐	☐	☐	☐	☐
58.	Passengers on railroads, killed in accidents	☐	☐	☐	☐	☐	☐	☐
59.	Motorcyclists killed in accidents	☐	☐	☐	☐	☐	☐	☐
60.	Bicyclists struck by automobiles and killed	☐	☐	☐	☐	☐	☐	☐
61.	Pedestrians struck by automobiles and killed	☐	☐	☐	☐	☐	☐	☐
		1	2	3	4	5	6	7

* * * * * END FOR THIS CHARACTERISTIC * * * * *

PART II: HOW MANY LIVES WOULD ONE GOVERNMENT PROGRAM HAVE TO SAVE TO MAKE IT WORTH AS MUCH AS ANOTHER GOVERNMENT PROGRAM?

Suppose you must decide between two government safety programs that each costs the same and each prevents 10 deaths from traffic accidents every year. The only difference is that the drivers whose lives are saved by the first government program are obeying all traffic laws, while the drivers whose lives are saved by the second government program are driving 30 mph over the speed limit. In other words, we want you to compare two government programs that prevent 10 accidental deaths of the following sort:

(1) |__________| Traffic accidents that kill drivers of automobiles who are obeying traffic laws (no other people involved).

(2) |__________| Traffic accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 30 mph (assuming the driver is not drunk and no one else is involved in the accident).

Do you think it is worth just as much to prevent deaths of drivers who are speeding by 30 mph, in comparison with drivers who are obeying the traffic laws? If so, put |___10___| in the answer spaces next to both Government Programs (1) and (2). That means you think both programs are worth the same, if each program prevents 10 deaths.

Or, do you think it is worth more to prevent deaths of drivers obeying the traffic laws, rather than drivers who are speeding? If so, put |___10___| next to Government Program (1) only.

Now we describe how to choose a number for Government Program (2). Suppose that Government Program (2) prevents 20 deaths each year among drivers who are speeding by 30 mph. Would you then think that Government Program (2) is worth as much as Government Program (1)? (Government Program (1) still prevents 10 deaths among law-abiding drivers.) What about 100 deaths (or 15) prevented by Government Program (2)? If you did not put 10 next to Government Program (2) earlier, then put some larger number (like 15, or 20, or 100, or perhaps even higher) that would make Government Program (2) worth just as much in your judgment. If you really feel that it is not very important to prevent accidental deaths of speeding drivers (where other people are not involved in the accidents), you can enter a very high number -- even a number as high as | 1 million | -- next to Government Program (2).

Suppose, for example, that you decide to write down 100 for Government Program (2). That means:

> "Government Program (2) would have to prevent 100 deaths of speeding drivers before I would say it is just as worthwhile as Government Program (1), which prevents the deaths of 10 law-abiding drivers."

The questions below are like the above example, except that more government programs are compared (up to 10 at one time). All programs cost the same. To answer each section, first go through the list of government programs and check off the cases (one or more) where preventing 10 deaths would be most worthwhile. (There may be several programs that seem most worthwhile, or all the programs may be equally worthwhile.) Put | 10 | in the answer spaces for those government programs. Second, put numbers larger than 10 into the answer spaces for the other government programs (which are less worthwhile). When you are done, the numbers of deaths prevented by the various government programs (10 or more) should make them worth the same in your judgment.

Just as in the example above, we describe below for each government program the hazard that can cause death and the type of people who are at risk of death. In a separate column, we also give the age group of the people whose deaths are prevented (usually ages 40-49).

DETAILS

The questions we ask below are not easy ones. If you are uncertain about how to answer the questions, the following details may help you:

- We are very specific about the types of people helped by the government programs. For example, we often say that only people aged 40 to 49 are helped. We are not being unfair to people of other ages. We just do not describe the government programs that help those other people. (We do not consider any hazards that hurt children, or any government programs that help children.)

- Only the kind of people we describe are saved from dying by the government programs. For example, we look at some automobile accidents that kill drivers and some accidents that kill passengers, but we never look at accidents that kill both drivers and passengers. Similarly, we look separately at automobile accidents that kill drunken drivers and automobile accidents that kill other drivers.

- We only look at government programs that prevent deaths. (Other government programs, which we do not describe, prevent injuries.)

- You may doubt that government programs can be set up which prevent deaths from the hazards we describe. However, please suppose for the sake of this study that such programs are possible. (Other studies will look at the question of whether these government programs could actually be set up.)

- All programs are supported from the general taxes of the U.S. government.

- The government programs do not "inconvenience" people (for example, by requiring bothersome safety equipment, or banning the sale of certain products).

- Deaths are reduced by the same proportion everywhere in the United States, for all kinds of people, regardless of whether they know about the hazard or not.

As you fill out this section, do not agonize over differences among government programs that are worth about the same. We are mainly interested in any big differences in worthiness that you feel should be recognized. Just give us your best personal judgment.

Take as much time as you like. We are happy to wait for your best judgment.

Additional instructions needed for later sections are given below.

* * * * * END OF INITIAL INSTRUCTIONS FOR PART II * * * * *

<table>
<tr><th>(Government Program Identifier)</th><th>Number of Deaths Prevented</th><th>Hazard/Type of People at Risk</th><th>Benefit of Government Program</th><th>Age Group among which Death Prevented</th></tr>
<tr><td colspan="5">Section A: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Automobile Traffic Accidents (Drivers):</td></tr>
<tr><td>(A1)</td><td></td><td>Traffic accidents that kill drivers of automobiles who are obeying traffic laws -- other people not involved</td><td>Death prevented</td><td>40-49</td></tr>
<tr><td>(A2)</td><td></td><td>Traffic accidents that kill drivers of automobiles who are exceeding the 55mph speed limit by 15mph (70mph, but not legally drunk) -- others not involved</td><td>(Same)</td><td>(Same)</td></tr>
<tr><td>(A3)</td><td></td><td>Traffic accidents that kill drivers of automobiles who are exceeding the 55mph speed limit by 30mph (85mph, but not legally drunk) -- others not involved</td><td>(Same)</td><td>(Same)</td></tr>
<tr><td>(A4)</td><td></td><td>Traffic accidents that kill drivers of automobiles who are exceeding the 55mph speed limit by 15mph and whose alcohol blood levels make them legally drunk -- others not involved</td><td>(Same)</td><td>(Same)</td></tr>
<tr><td colspan="5">Section B: Comparison among Equally Costly Government Programs to Reduce the Risk of Fatal Accidents Involving Regularly Scheduled Airlines (Pilots, Crews, Passengers, and People on the Ground):</td></tr>
<tr><td>(B1)</td><td></td><td>Passengers</td><td>Death prevented</td><td>40-49</td></tr>
<tr><td>(B2)</td><td></td><td>Pilots and crews</td><td>(Same)</td><td>(Same)</td></tr>
<tr><td>(B3)</td><td></td><td>People on the ground who have chosen to buy a less expensive house near an airport</td><td>(Same)</td><td>(Same)</td></tr>
<tr><td>(B4)</td><td></td><td>People on the ground who are not near an airport or other area with high airplane traffic</td><td>(Same)</td><td>(Same)</td></tr>
</table>

REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

* * * * * ADDITIONAL INSTRUCTIONS * * * * *

AGE GROUP AMONG WHICH DEATH PREVENTED

Usually, people saved by the government programs are in the 40-49 age group. However, in a few cases the people saved by the government programs are in other age groups (20-29, 60-69, or 80-89). Please take this into account when comparing the government programs in Sections C, E, and L.

* * * * * END OF ADDITIONAL INSTRUCTIONS * * * * *

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented

Section C: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Automobile Traffic Accidents (Drivers in Various Age Groups)

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented
(C1)		Drivers of automobiles, obeying traffic laws -- other people not involved	Death prevented	20-29
(C2)		(Same)	(Same)	40-49
(C3)		(Same)	(Same)	60-69
(C4)		(Same)	(Same)	80-89

Section D: Comparison among Equally Costly Government Programs to Reduce the Risk of Fatal Automobile Traffic Accidents (Drivers and Passengers)

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented
(D1)		Drivers of automobiles, obeying traffic laws -- other people not involved	Death prevented	40-49
(D2)		Passengers in automobiles whose drivers are obeying traffic laws -- others not hurt	(Same)	(Same)
(D3)		Drivers of automobiles, exceeding the 55mph speed limit by 30mph (85mph), but not legally drunk -- others not involved	(Same)	(Same)
(D4)		Passengers of automobiles whose drivers are exceeding the 55mph speed limit by 30mph (85mph), but driver not legally drunk -- others not hurt	(Same)	(Same)

REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

* * * * * ADDITIONAL INSTRUCTIONS * * * * *

BENEFIT OF GOVERNMENT PROGRAM

Usually, people saved by the government programs are just as healthy afterward as other people their age, and they have the same life expectancy. However, in a few cases the people saved by the government programs are not as healthy. In particular, we look at a few cases where "the life expectancy of survivors is only half of average for the indicated age group." Please take this into account when comparing the government programs in Sections E, L, and R.

* * * * * END OF ADDITIONAL INSTRUCTIONS * * * * *

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented
Section E: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Cancer from Air Pollution (Various Age Groups and Life Expectancies):				
(E1)		Cancer from air pollution	Death prevented	20-29
(E2)		(Same)	Death prevented	40-49
(E3)		(Same)	Death prevented	60-69
(E4)		(Same)	Death prevented	80-89
(E5)		(Same)	Death prevented, but life expectancy of survivors is only half of average for the indicated age group	40-49
(E6)		(Same)	Death prevented, but life expectancy of survivors is only half of average for the indicated age group	60-69

Section F: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Cancer from Various Causes:				
(F1)		Cancer from air pollution	Death prevented	40-49
(F2)		Cancer from manmade radiation in the general environment	(Same)	(Same)
(F3)		Cancer from smoking cigarettes	(Same)	(Same)
(F4)		Cancer from unauthorized dumping of toxic waste in residential areas	(Same)	(Same)
(F5)		Cancer from residual insecticides and herbicides in foods	(Same)	(Same)
(F6)		Cancer from artificial sweeteners	(Same)	(Same)
(F7)		Cancer from intrauterine devices (IUDs)	(Same)	(Same)
(F8)		Cancer from chemical pollution of streams, lakes and rivers	(Same)	(Same)

↑ REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented

Section G: Comparison Among Equally Costly Government Programs to Reduce the Risk of Various Diseases and Other Fatal Medical Problems

(G1)	____________	Cancer from air pollution	Death prevented	40-49
(G2)	____________	Heart attack	(Same)	(Same)
(G3)	____________	Stroke	(Same)	(Same)
(G4)	____________	Botulism poisoning in canned foods purchased at a grocery store	(Same)	(Same)

Section H: Comparison Among Equally Costly Government Programs to Reduce the Risk of Deaths from Various Diverse Hazards:

(H1)	____________	Traffic accidents that kill drivers of automobiles who are obeying traffic laws -- other people not involved	Death prevented	40-49
(H2)	____________	Airplane accidents that kill passengers of regularly scheduled airlines	(Same)	(Same)
(H3)	____________	Fires from faulty electrical wiring in single-family houses	(Same)	(Same)
(H4)	____________	Fires from faulty electrical wiring in office buildings	(Same)	(Same)
(H5)	____________	Tornadoes	(Same)	(Same)
(H6)	____________	Drownings while swimming in a supervised pool	(Same)	(Same)
(H7)	____________	Policemen killed in the general line of duty	(Same)	(Same)
(H8)	____________	Highway accidents killing long-haul truck drivers, obeying traffic laws	(Same)	(Same)
(H9)	____________	Cancer from air pollution	(Same)	(Same)
(H10)	____________	Heart attack	(Same)	(Same)

Section I: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Accidents Involving Electric Hair Dryers (or House Wiring):

(I1)	____________	Fires from faulty electrical wiring in single-family houses	Death prevented	40-49
(I2)	____________	Fires in single-family houses from leaving hair dryers running near flammable material	(Same)	(Same)
(I3)	____________	Electrocution from using hair dryers while bathing	(Same)	(Same)

↑ REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented

Section J: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Fires in Single-Family Houses (Various Causes):

(J1)		Faulty electrical wiring	Death prevented	40-49
(J2)		Faulty gas room heaters	(Same)	(Same)
(J3)		Faulty Christmas tree lights	(Same)	(Same)
(J4)		Lightning causing fires	(Same)	(Same)
(J5)		Inhabitants falling asleep while smoking	(Same)	(Same)

Section K: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Fires from Faulty Electrical Wiring in Various Types of Buildings:

(K1)		Single-family houses	Death prevented	40-49
(K2)		Apartment buildings	(Same)	(Same)
(K3)		Office buildings	(Same)	(Same)
(K4)		Night clubs	(Same)	(Same)

Section L: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Heart Attacks (Various Age Groups and Life Expectancies):

(L1)		Heart attack	Death prevented	20-29
(L2)		(Same)	Death prevented	40-49
(L3)		(Same)	Death prevented	60-69
(L4)		(Same)	Death prevented	80-89
(L5)		(Same)	Death prevented, but life expectancy of survivors in only half of average for the indicated age group	40-49

REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented

Section M: Comparison Among Equally Costly Government Programs to Reduce the Risk of Deaths from Various Types of Natural Disasters:

(M1)		Tornadoes	Death prevented	40-49
(M2)		Lightning causing fires in single-family houses	(Same)	(Same)
(M3)		Flash floods striking travelers with no warning	(Same)	(Same)
(M4)		Flash floods striking people who chose to buy a less expensive house in a known flood plain	(Same)	(Same)
(M5)		Lightning striking people	(Same)	(Same)
(M6)		Extraordinarily high storm tides, killing people who have chosen to live at the beachfront	(Same)	(Same)

Section N: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Occupational Accidents:

(N1)		Coal mining	Death prevented	40-49
(N2)		Pilots and crews of regularly scheduled airlines	(Same)	(Same)
(N3)		Farmers on tractors	(Same)	(Same)
(N4)		Firemen killed in the general line of duty	(Same)	(Same)
(N5)		Policemen killed in the general line of duty	(Same)	(Same)
(N6)		Long-haul truck drivers on highways, who are obeying traffic laws	(Same)	(Same)
(N7)		Highway construction workers	(Same)	(Same)
(N8)		Construction and repair work high above the ground (by ironworkers, steeplejacks, etc.)	(Same)	(Same)
(N9)		Movie stunt men	(Same)	(Same)
(N10)		Fires in office buildings	(Same)	(Same)

REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented

Section O: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Occupational Diseases:

(O1)		Cancer from air pollution	Death prevented	40-49
(O2)		Cancer from having worked in a job where there was no information of increased cancer risk	(Same)	(Same)
(O3)		Cancer from having worked in a job where there was extensive information of much increased cancer risk	(Same)	(Same)

Section P: Comparison of Equally Costly Government Programs to Reduce the Risk of Fatal Medical Conditions Associated with Personal-Use Decisions:

(P1)		Cancer from cigarette smoking	Death prevented	40-49
(P2)		Cancer from artificial sweeteners	(Same)	(Same)
(P3)		Cancer from intrauterine devices (IUDs)	(Same)	(Same)
(P4)		Cirrhosis of liver from extreme alcohol consumption	(Same)	(Same)
(P5)		Drug overdoses by drug addicts	(Same)	(Same)

Section Q: Comparison of Equally Costly Government Programs to Reduce the Risk of Fatal Recreational Accidents:

(Q1)		Drownings while swimming in a supervised pool	Death prevented	20-29
(Q2)		Drownings while swimming alone in an abandoned quarry clearly marked as "dangerous" and "private property -- keep out"	(Same)	(Same)
(Q3)		Drownings while boating	(Same)	(Same)
(Q4)		Drownings while scuba diving	(Same)	(Same)
(Q5)		Accidents while driving automobiles on highways, obeying traffic laws -- other people not involved	(Same)	(Same)

REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

(Government Program Identifier)	Number of Deaths Prevented	Hazard/Type of People at Risk	Benefit of Government Program	Age Group among which Death Prevented
Section R: Comparison of Equally Costly Government Programs to Reduce the Risk of Fatal Complications during Various Types of Surgical Operations:				
(R1)		Operations on drivers of automobiles (obeying traffic laws) involved in accidents	Death prevented	40-49
(R2)		Operations to slow the progression of diseases that are expected to cause death eventually	Death prevented, but life expectancy of survivors is only half of average for the indicated age group	(Same)
(R3)		Operations to alleviate severe pain	Death prevented	(Same)
(R4)		Major cosmetic surgery	Death prevented	(Same)
Section S: Comparison Among Equally Costly Government Programs to Reduce the Risk of Fatal Accidents from Various Types of Transportation:				
(S1)		Passengers in automobiles whose drivers are obeying traffic laws -- others not hurt	Death prevented	40-49
(S2)		Passengers on intercity buses	(Same)	(Same)
(S3)		Passengers on regularly scheduled airlines	(Same)	(Same)
(S4)		Passengers on small private planes with non-professional pilots	(Same)	(Same)
(S5)		Passengers on railroads	(Same)	(Same)
(S6)		Motorcyclists	(Same)	(Same)
(S7)		Bicyclists struck by automobiles	(Same)	(Same)
(S8)		Pedestrians struck by automobiles	(Same)	(Same)
(S9)		Long-haul truck drivers on highways, obeying traffic laws	(Same)	(Same)

REMEMBER: The larger the number of deaths prevented (your judgment), the less important is each death of that type.

PART III. HOW MUCH ADDITIONAL INCOME TAXES WOULD YOUR FAMILY PAY FOR A NEW GOVERNMENT HEALTH OR SAFETY PROGRAM?

The above questions in Part II assume that existing tax money is given to the most worthwhile government health and safety programs. Now we suppose that new tax money will be raised for new government programs. In particular, please suppose that the income taxes of everyone in the United States will rise to support programs that will decrease deaths from different hazards.

Below we describe 12 government health and safety programs, in terms of the hazards that can cause death and the type of people who are exposed to that risk (just as we did in Part II). All people helped by the government programs are in the 40-49 age group. Each government program prevents either 10 deaths per year or 1000 deaths per year.

Look at each box on the next page separately. If that particular government program were the only new program, how much would your family be willing to pay each year in additional income taxes to raise money for it? Please tell us the maximum amount of additional income taxes your family would be willing to pay, if absolutely necessary. Assume that the income taxes of everyone else will rise by the same proportion. (It may turn out that the program will cost less money, so the tax increase will be smaller.) Consider both the box where the program prevents 10 deaths per year and the box where it prevents 1000 deaths per year.

Please suppose for the sake of this study that government programs could be set up to prevent deaths from the hazards we describe, even though you may have doubts. (Other studies will look at the question of whether these government programs actually could be set up.)

(Government Program Identifier)	Hazard/Type of People at Risk	Maximum Amount of Additional Income Taxes Your Family Would Be Willing to Pay Each Year to Prevent U.S. Deaths If Absolutely Necessary	
		10 Deaths per Year	1000 Deaths per Year
(1)	Traffic accidents that kill drivers of automobiles who are obeying traffic laws -- others not involved		
(2)	Traffic accidents that kill drivers of automobiles who are exceeding the 55 mph speed limit by 30 mph (85 mph, but not legally drunk) -- others not involved		
(3)	Passengers of regularly scheduled airlines in accidents		
(4)	Cancer from air pollution		
(5)	Cancer from smoking cigarettes		
(6)	Cancer from artificial sweeteners		
(7)	Heart attacks		
(8)	Fires from faulty electrical wiring in single-family houses		
(9)	Fires in single-family houses from inhabitants falling asleep while smoking		
(10)	Fires from faulty electrical wiring in office buildings		
(11)	Highway accidents killing long-haul truck drivers who are obeying traffic laws		
(12)	Policemen killed in the general line of duty		

PART IV. BACKGROUND INFORMATION

It would help us check that we have talked to all kinds of people for our study, if you could tell us about yourself and your family. Please circle the responses that best answer the following questions:

1.	What is your sex?	(Female/ Male)
2.	What is your marital status?	(Single/ Married/ Other)
3.	How would you describe the area in which you now live?	(Rural/ Small town/ Small city/ Large city/ Suburb)
4.	How would you describe the area in which you were raised?	(Rural/ Small town/ Small city/ Large city/ Suburb)
5.	In what area of the United States were you raised?	(Northeast/ Southeast/ Midwest/ Southwest/ Mountain states/ West/ not U.S.)
6.	What is your current age?	(Under 20/ 20-29/ 30-39/ 40-49/ 50-59/ 60-69/ 70 or over)
7.	What is the highest level of schooling that you have completed?	(Grade school/ 9th grade/ High school/ 2 years college or technical school/ 4 years college/ Masters degree/ Doctorate)
8.	How would you describe your general voting preferences?	(Democrat/ Republican/ Independent/ Non-voter)
9.	Are you active in a political party or other political organization?	(Yes/ Occasionally/ No)

10.	With which of the following ethnic or racial groups do you identify most closely?	(Black/ Hispanic/ Asian/ White/ Other/ None)
11.	Are you active in a church or other religious organization?	(Yes/ Occasionally/ No)
12.	Which of the following best describes your current (or past) religious background?	(Not relevant/ Roman Catholic/ Eastern Orthodox/ Protestant-Fundamentalist/ Protestant-Other/ Jewish/ Muslim/ Other)
13.	How many children do you have?	(None/ 1/ 2/ 3/ 4/ 5 or more)
14.	How many in your household are employed?	(None/ 1/ 2/ 3/ 4 or more)
15.	What is your total annual household income (wages, interest, dividends, etc., before income taxes)?	(Under $10,000/ $10,000 to $19,000/ $20,000 to $29,000/ $30,000 to $39,000/ $40,00 to $59,000/ Over $60,000)

16. Which one of the following general categories best describes your current occupation? (Put an "X" between the parentheses next to the most representative job category.)

Professional and Technical: (Examples: Accountants; computer programmers; civil, chemical, electrical engineers; lawyers; doctors; registered nurses; scientists; teachers; artists; clergy; religious education workers; etc.) ( )

Managers, Officers and Proprietors: (Examples: Department heads; sales managers; administrators; executive buyers; company officers; etc.) ( )

Farmers (owners and managers) ( )

Clerical or Sales Workers: (Examples: Bank tellers; mail carriers; office machine operators; clerical workers; secretaries; sales persons; insurance and real estate agents; etc.) ( )

Craftsmen and Foremen: (Examples: Carpenters; electricians; road equipment operators; mechanics and repairmen; painters; plumbers; telephone installers; tool and die makers; etc.) ( )

Operatives: (Examples: Bus taxi, and truck drivers; food graders and packers; meat cutters; laundry operatives; gas station attendants; etc.) ( )

Service Workers and Other Similar Jobs: (Examples: Restaurant workers; janitors; car washers; groundskeepers; farm workers; laborers; etc.) ( )

Military Service . . . . ( )

Homemaker . . . . ( )

Student . . . . ( )

Retired . . . . ( )

Some other occupation (Specify: ______________________________) ( )

THANK YOU

We greatly appreciate your answering this long and difficult questionnaire. Of course, your answers will be held in strictest confidence and never attributed to you personally.

This questionnaire is being administered in a number of different versions of different lengths. About how long did it take you to fill out this particular version? (_____ hours, _____ minutes)

If you would like to receive a short report summarizing the general pattern of results from this study, please write your name and mailing address below:

____

____

____

____

APPENDIX E

RESPONSE TO COMMENTS BY REVIEWERS OF THE DRAFT FINAL REPORT

This appendix summarizes my reactions to major points raised by reviewers of the draft final report, Diverse Risks and the Relative Worth of Government Health and Safety Programs: An Experimental Survey, June 1984. It proceeds roughly in reverse chronological order, discussing comments by Bill Desvousges, Jan Acton, Ann Fisher, Jon Harford, and Reed Johnson. Issues common to several reviews are discussed only once. The reviewers provided constructive comments regarding refinements both in presentation of these results and for future extensions of the research.

Bill Desvousges Letter of October 26, 1984

The questionnaire can be categorized as a type of contingent valuation survey, and many of the general principles applicable to other such surveys are certainly applicable here as well. However, the purpose of the project was not to develop an improved survey technique that would be appropriate for a broad range of valuation questions associated with measuring the WPT for environmental benefits of government regulations. Instead, the questionnaire was designed very specifically for valuing reductions in diverse risks, where government programs are hypothesized to cause the risk reductions. I suspect that the technique used in Part II of the questionnaire would be inferior by itself as a basis for estimating the WTP for most environmental benefits.

The central feature of the valuation of reductions in diverse risks that makes it different from most other EPA benefits estimates is the focus on "altruistic" considerations rather than on personal benefits (as discussed in Appendix A, particularly near the end). The most relevant question is not "Would you pay more to have your probability of dying reduced by 10^{-6} next year when you are driving, or when you are smoking cigarettes?". Rather, the more relevant questions (in bald form) are "Would you benefit from this government program more than the average taxpayer?", and "How much weight do you attach to benefits of this type that will be received by other taxpayers?". Interdependence of utility functions becomes a central consideration, rather than a complication that can be safely ignored.

In this context, simulating voting seems more relevant than designing a questionnaire to approximate a "simulated market, with a well framed commodity and payment vehicle". To the extent that a questionnaire simulates market choices very similar to spending decisions that the respondent often makes, I suspect that good estimates of absolute WTPs can be obtained from a good questionnaire. Unfortunately, this close similarity to actual markets may not be possible for the valuation of reductions in diverse risks. In some ways the questionnaire's interpretation is more straightforward than is typically the case for contingent valuation surveys (particularly if one is satisfied to measure relative WTPs rather than absolute WTPs).

There appears to be no significant violation of economic theory from measuring relative WTPs among government health and safety programs, and considering absolute WTPs to be a separable issue. The results are then relevant for allocating a total government budget for health and safety among various programs, but do not address the issue of how much should be allocated altogether to health and safety.

The current version of the questionnaire would be too long and difficult for a random sample of U.S. voters. However, a fairly long questionnaire asking about relative numbers of lives saved has the advantage that it is possible to ask the same question in different contexts, and to measure the consistency of responses. Most respondents in fact answered reasonably consistently, and were not bothered excessively by the knowledge that their responses were not perfectly transitive. (Participants were told that only roughly consistent responses were expected.)

Jan Acton's Comments in Ann Fisher's Letter of November 5, 1984

The main conclusion of the study is that the type of questionnaire used appears to be workable, meaningful, and useful for EPA. There is no claim that the results are representative of the U.S. population.

A different issue is that there appear to be wide differences of preferences within the sample population concerning the appropriate tradeoffs. For simple samples of size 15, the interquartile range can be interpreted as a 90% confidence intervals, as noted at the bottom of p. 16. (The truly appropriate 90% confidence intervals are presumably somewhat larger than the interquartile range in Table 2, because the distribution of estimated coefficients -- rather than direct observations -- is being summarized; however, I believe that the interpretation given is not misleadingly inaccurate.) These confidence intervals in Table 2 are wide.

We have not yet shown statistically significant evidence that many of the true average (relative) WTPs are different within the sampled population. However, it seems clear for most individual respondents that the distinctions being made in Part II of the questionnaire are meaningful and reasonably accurate. (See the high significance levels reported in the third column of Table 7.) The upshot is that a larger sample is needed, but it is worth gathering because the method works.

The term "utility function" is used generally in economics for a function that summarizes choices, even if they are not the specific kinds of choices that interested Marshall. (For example, the Friedman-Savage utility function, explaining choices among uncertain outcomes, is very different from a Marshallian utility function -- for one thing, it must be cardinal rather than ordinal.) The term "basic utility function" is perhaps a little clumsy, but not incorrect. (I would be happy to receive suggestions regarding alternatives.)

Jan makes an astute observation that regression of the Part III relative WTPs on the Part II relative WTPs implicitly treats the latter as "truth" (pp. 40-46). I considered using a symmetrical statistical treatment, but could not immediately think of one more convenient than that presented. In any case, no conclusions were based on interpreting the Part II WTPs as "truth." I basically just used the multiple correlation coefficients and slope signs of the regressions (which are in fact symmetrical statistics, unlike the regression slopes).

Ann Fisher Letter of October 11, 1984

Even if the absolute levels of responses to Part III of the questionnaire have doubtful meaning, the relative valuations from Part III may be just as accurate as those from Part II. It appears very worthwhile to investigate further the reasons that discrepancies arose between the relative valuations in Parts II and III.

Where survivors benefiting from government programs have a halved life expectancy, the questionnaire instructions on p. D-20 explicitly say they are "not as healthy". I verbally told participants to interpret this as losing the "middle years" of one's life, and experiencing health typical of the "final years." (In early versions of the questionnaire there were more detailed instructions of this sort, but they were considered too complicated and edited out at the suggestion of reviewers.)

I do not think there is any substantial discrepancy between the time frames used in Parts I and II of the questionnaire. In Part I respondents are asked about "voluntariness" in terms of an early decision. In part II they are asked about later government programs to help rescue those people whose decisions turned out badly. The definition of voluntariness in terms of early decisions may or may not be the most relevant risk characteristic. (A different voluntariness variable could be defined in terms of the later difficulty of changing one's mind, and both variables could in principal be relevant.) However, there does not appear to be any logical inconsistency. Regarding the pattern of results for cigarette smokers versus smoking in bed, my hypothesis is that these results are explained by risk characteristics other than voluntariness. (Note that Tables 2 and 6 give quite different results for smoking in bed versus cancer from smoking, another puzzle worthy of future investigation.)

It can be argued that the appropriate overall criterion for making moderate adjustments to government health and safety programs should be to maximize the total number of lives saved, after weighting the lives according to their risk characteristics. This principal corresponds to accepting a constant WTP for saving lives of each risk type, or requiring that the WTP for a government program be proportional to the number of lives saved. I think I could convince most people of the appropriateness of this type of decision rule, if I talked to them at length. Thus, I remain convinced that diminishing marginal WTP for life saving (over the range of fatality numbers considered in Part III of the questionnaire) is not a preference that most people would maintain after extended analysis and reflection. It may be that observed diminishing WTP is largely an artifact of short-cut methods of making decisions that most people use for most problems, particularly unfamiliar problems; it is a common result in other questionnaires, as in this one. For our purposes, the most relevant information is what people would prefer after extended analysis and reflection, since the central issue is what ought to be, not explaining what has happened historically. Unfortunately, I am not convinced that a one hour questionnaire can be designed that will clearly achieve this objective.

Jon Harford Comments of September 1984

Jon suggests that a presumably ordinal ranking should not be treated as a regression variable, and that the proper method is to use a series of dummy variables. In general when estimating regression equations summarizing human behavior, the precisely appropriate functional form is not know. Linear variables are usually specified for convenience. Sometimes it is possible to estimate non-linear relationships, usually approximated most conveniently by including a quadratic term. Including a dummy variable for each point on a seven-point scale is mathematically equivalent to attempting to estimate a sixth-degree polynomial. I did not experiement with nonlinear regressions, but it is doubtful that there is sufficient information in the sample to warrant such a specification. In more practical terms, valuable degrees of freedom would be used up for no good purpose. Even if it were possible to elicit from respondents the precise ratio of their exposure to that of the average person, that still would not make a linear specification for the Risk-Characteristics Utility Function more than the approximation it already is with the "ordinal" variable. My choice of an ordinal variable and the linear specification is a matter of statistical convenience and judgment.

Jon raises the issue of whether people's valuations of specific risks have more to do with their valuations of the type of person facing the risk than with the nature of the death itself. It could be useful to investigate this issue, for example, where results of the survey are to be extrapolated to a new situation involving both different types of risks and people. Or it could be useful if one doubted that respondents have a good idea what type of people in fact die in certain types of accidents. However, if the objective is simply to get policy-relevant information in the most efficient manner possible (rather than to investigate scientifically interesting questions), it seems that the straightforward solution is to modify the questionnaire. That is, include a new government safety program or additional information about the kinds of people who in fact die from certain causes. The Basic Utility Function would then capture the information needed for policy making.

Reed Johnson Comments of September 1984

Reed was concerned that the questions were not couched explicitly in probabilistic terms. I do not believe that any essential considerations were omitted thereby. Presumably respondents realize that they have only a probabilistic chance of being one of the (say) 10 fatalities prevented by a specified government program. The questionnaire asks about the WTP schedule needed for policy analysis in such a directly relevant way that the operation of the underlying choice mechanisms (in terms of risk aversion, etc.) need not be investigated.

Since there is no assumption in my report that the numeraire program is valued equally by all respondents, the trade-offs can be compared across individuals. (As discussed in the second paragraph on p. 51, choice of numeraire can make a difference when calculating the average WTP across the population; some kind of standardizing of WTPs before averaging probably is justified.)

As noted in the next to last paragraph on p. 51, there are a number of other studies whose relationship to this one deserves to be analyzed. However, this study is sufficiently different that I did not use other literature directly. Project resources were insufficient to mount a special effort to relate this study to the broader literature base.